POWER TOPICS CROSS-INDEX

STEAM GENERATION
POWER GENERATION
WATER POWER
DIESEL & GAS ENGINES
AIR CONDITIONING & HEATING
REFRIGERATION
PUMPS & COMPRESSORS
STEAM SERVICES
ELECTRICITY & ELEVATORS
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SEPTEMBER, 1939

50,000 lb per hr capacity for Wilshire Oil Company 56
Letters from a turbine specialist—first of a series 59
Extra insulation improves boiler-room efficiency 60
Liberty, Texas, installs convertible diesel-gas engines 62
Speed-up improves elevator operation in 70-story bldg 63
Huettner rotative unit combines boiler and turbine 65
Hydraulic couplings control speed of boiler-feed pumps 66
Electric heat saves, maintains fuel-oil temperature 68
Gas turbine highlights ASME San Francisco meeting 69
California, here I come—Phil Swain visits the West 72
Refrigeration methods and equipment—16-page section 75
Engineer's heaven—new steam plant at Provo, Utah 91
Power-plant design puts its best foot forward 94
Photopage on new British steamship Mauretania 98

THE OPERATING ENGINEER

Step-by-Step Improvements 99
Picture Record 101
Switch in Time 102
Second-Hand Boilers 103
Practical Aids 104
Readers' Problems 108
Argument Corner 111
Questions and Answers 112
How to Splice Two-Ply Leather Belts in Your Plant 113

OTHER DEPARTMENTS

Exhaust Lines 61
Engineers' Bookshelf 116
Power Lines 118
Data Sheet No. 86 126
New Plant Equipment ... 128
George Edwards 134
Current Comment 152
Straws 160

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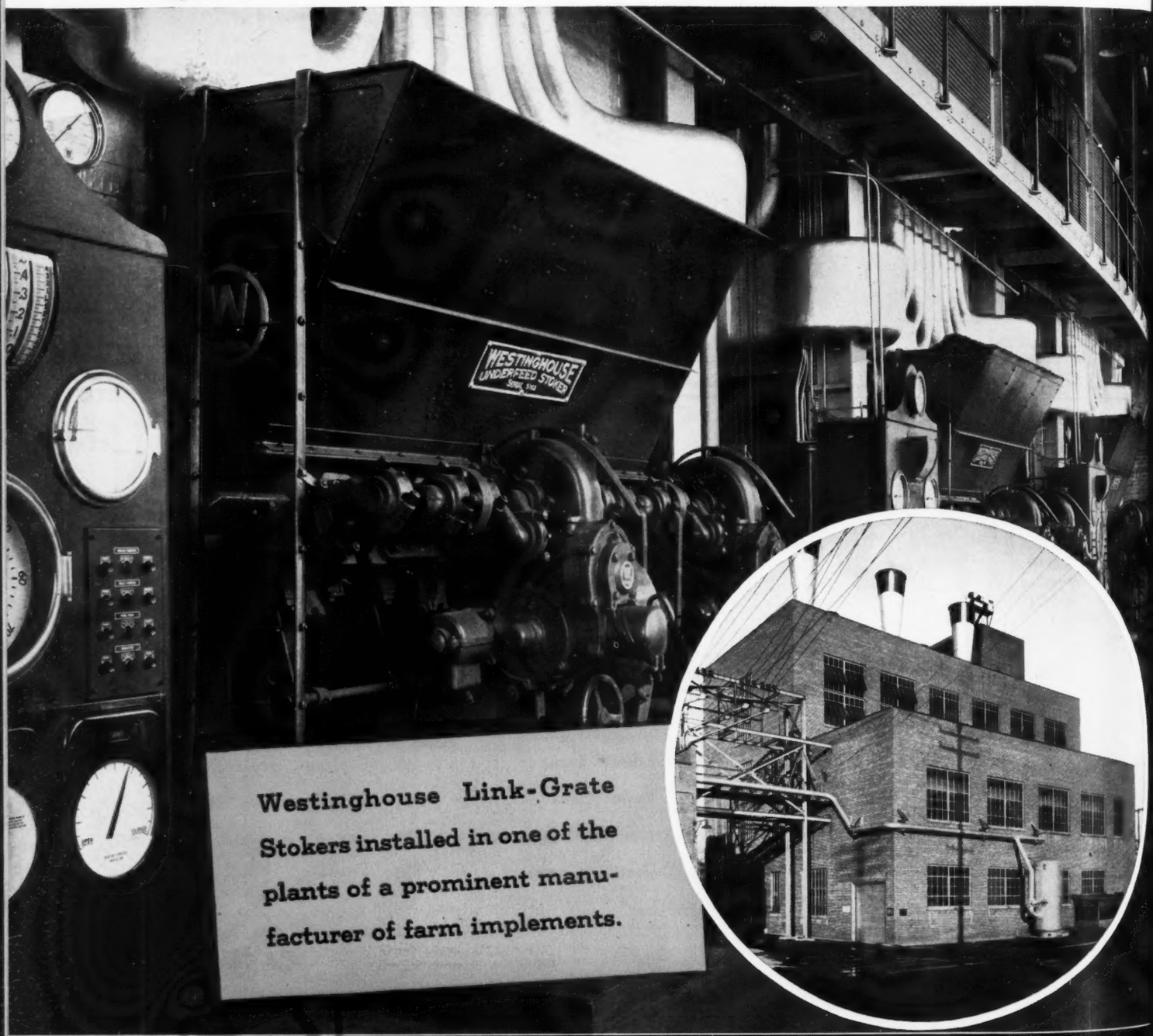
9 WESTINGHOUSE

cut Production Costs in



Westinghouse Link-Grate Stokers installed in one of the plants of a prominent manufacturer of farm implements.

Westinghouse

POWER

Established 1882 PHILIP W SWAIN, Editor

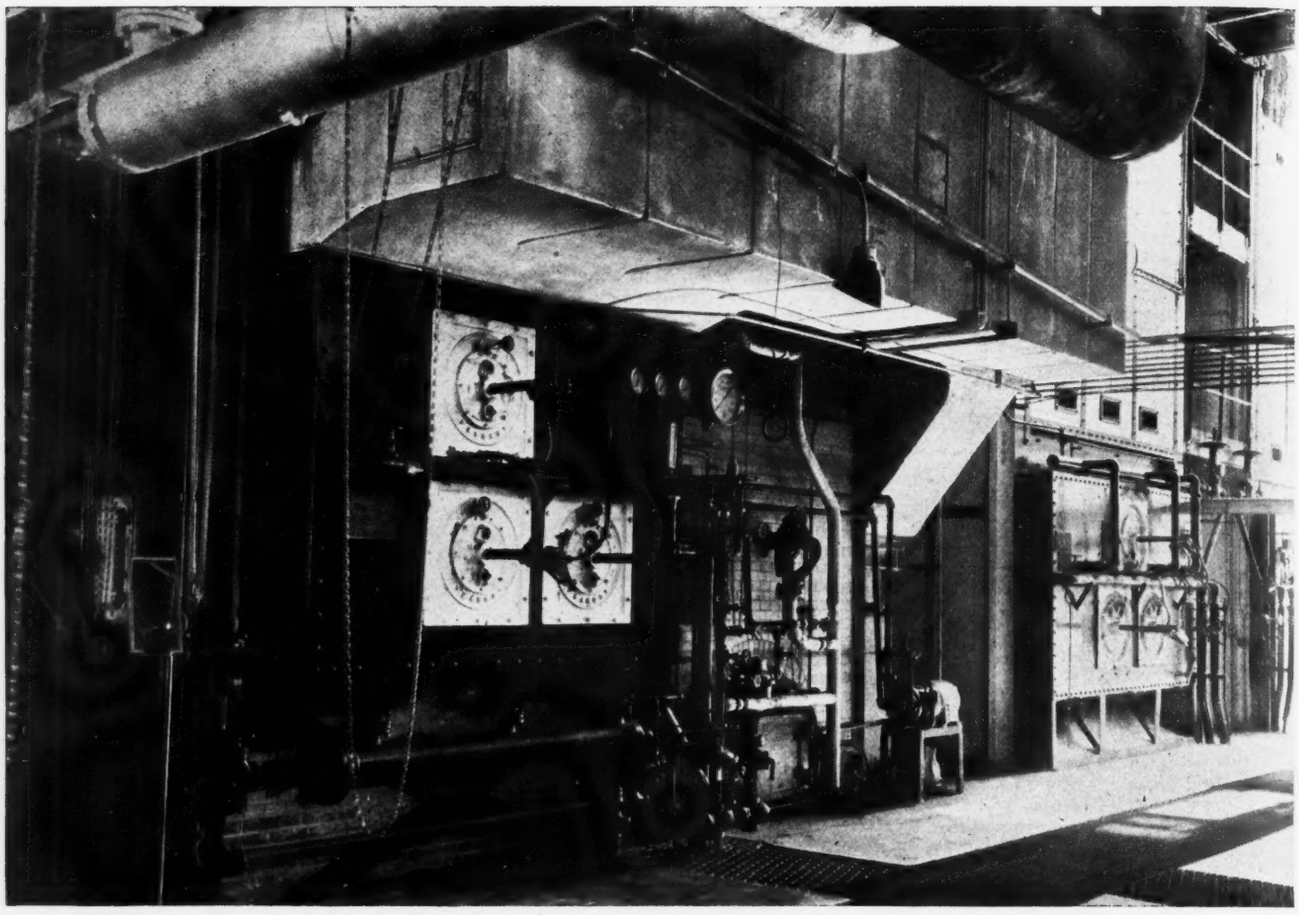
Tinker to Evers to Chance, 1939

Dizzy Dean is a great ball player. Lou Gehrig is a great ball player. But they play different brands of ball. Dizzy is an individualist; Lou plays for and with the team. Baseball history sparkles with the names of Home-Run Caseys who were great individual players. But managers keep their fingers crossed—they never know when the player will try for a home-run and risk a fly-out—when he's been signalled to bunt. Consistent, winning ball takes a *team.*

Other ball clubs have brighter individual stars, fielders with fatter batting averages, pitchers with sharper curves. But the Yankees, with three straight World Series triumphs under their belts, seem well on their way to a fourth. Why? Because the Yanks are a *team.* The catcher backs up the first baseman on a throw from infield. The shortstop-first base combination sticks together tighter than Damon and Pythias. It is as if that fabled Cub threesome—Tinker to Evers to Chance—were multiplied by three.

That's how to play pennant-winning ball, and how to keep steam in a boiler—teamwork. America's greatest living power engineer can't keep steam up alone. He must be backed by a balanced and integrated staff from fireman to shift engineer. That staff, further, must possess the ability to get along with other plant departments, just as surely as a ball team must get along with its fans. Any other course leads to the pop bottles of trouble.

Cooperation, mutual trust and understanding —a readiness to fight for the team instead of for individual glory or pay—that's the key to cheaper kilowatts just as surely as it's the key to a winning ball club. Be your staff two or twenty, the surest road to success is cooperation, the teamplay exemplified by the byword "Tinker to Evers to Chance."



New 50,000-lb-per-hr integral-furnace boiler, gas and oil fired. Two of the older boilers are visible at right

More Double-Duty Process Steam for Wilshire Oil

All electrical power is purchased, yet steam is generated at 450 lb and most of it does work in two expansion steps before use in process, boiler-feed heating and makeup evaporation

OUTSTANDING EXAMPLE of by-product-power production without electrical generation, the refinery of Wilshire Oil Co, Norwalk, Calif., increased its steam capacity in 1938 by adding another 50,000-lb-per-hr boiler. This big refinery went into operation in 1935. Its power plant was described briefly on page 548 of Mid-Sept POWER, 1937, and its basic hookup shown by one of the models (page 682) in the December, 1938, number.

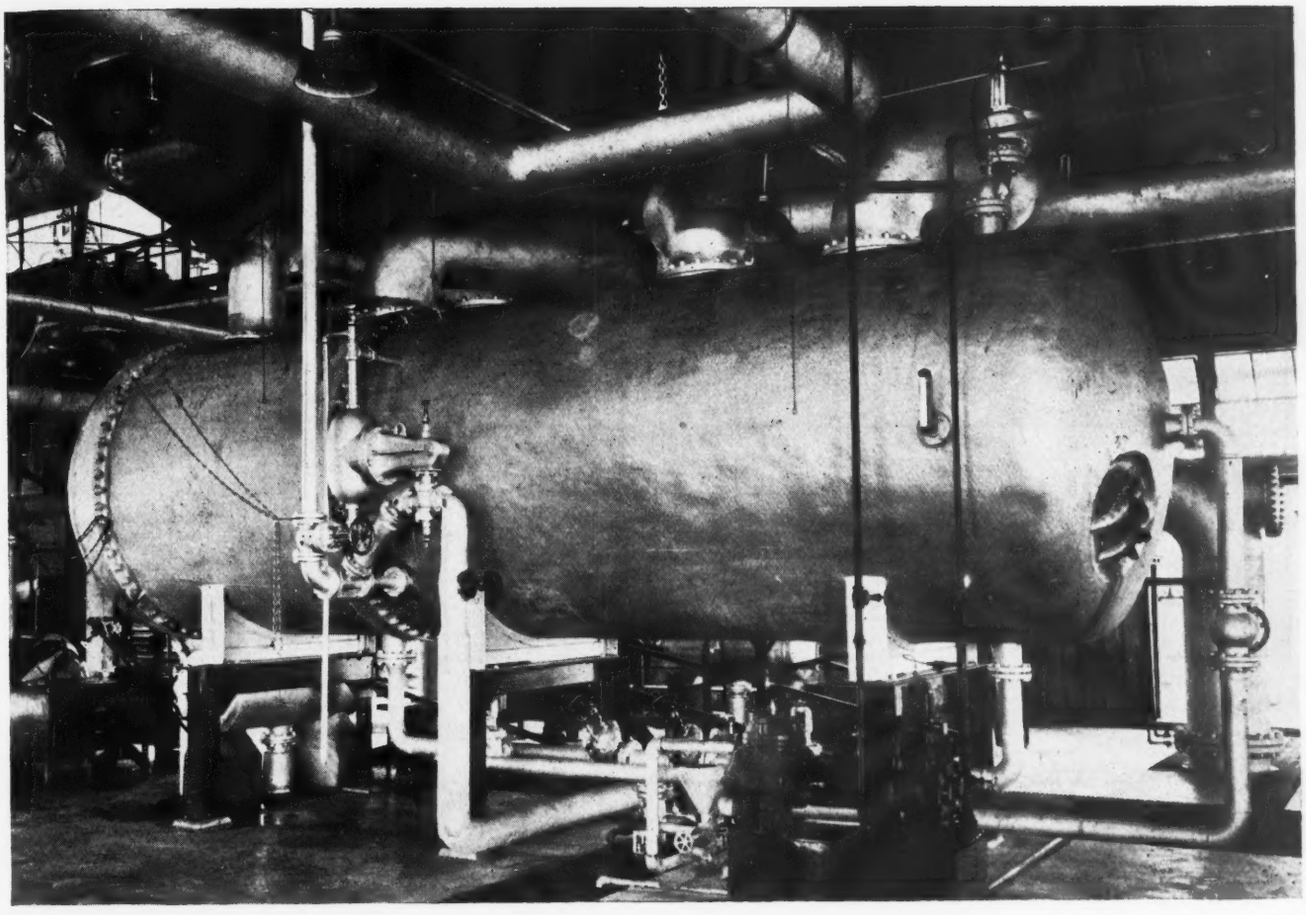
In brief, the 1935 installation consisted of four 30,000-lb-per-hr Foster-Wheeler gas-and-oil fired boilers. These generate steam at 450 lb and 580 F. The new unit (same steam conditions) is a Babcock and Wilcox integral-furnace boiler.

Primary consumers of the 450-lb steam are the seven turbine-driven pumps for circulating 110-lb pressure water for refinery condensers and other processing. Six of these pumps were installed in 1935 and one in 1938. Each unit is a 3600-rpm, 330-hp Elliott turbine geared to a 4000-gpm, 1750-rpm pump. The main boiler-feed pumps also take steam at 450 lb.

All 450-lb units exhaust at 150 lb to a main serving all other steam-driven equipment in both refinery and power plant. These, in turn, exhaust to the 10-lb main that supplies process heat throughout the refinery, also the deaerating heaters and the evaporator for boiler make up (which average 40%).

Major units in the expansion range from 150 lb to 10 lb are three 3600-rpm, 1100-hp Elliott turbines direct connected to Worthington hot-oil pumps, two large steam-engine-driven reciprocating oil-transfer pumps and scores of smaller pumps.

The boiler plant must, of course, be



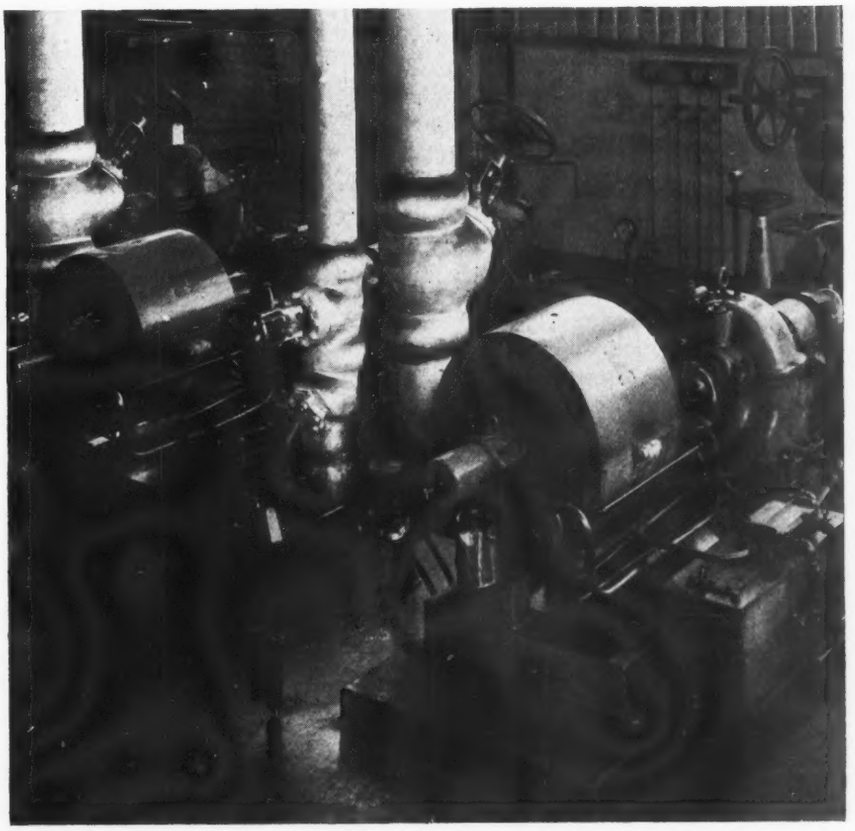
Evaporator has been lengthened to provide 33% more makeup capacity

operated to deliver steam equal to the maximum momentary requirements at any one of the three pressure levels (450 lb, 150 lb, or 10 lb). In general, consumption is greatest at the 150-lb level, so that some steam must be reduced from 450 lb to 150 lb and some of the 10-lb steam must be spilled into the evaporator condenser without going to process. Total boiler-plant load averages about 118,000 lb per hr.

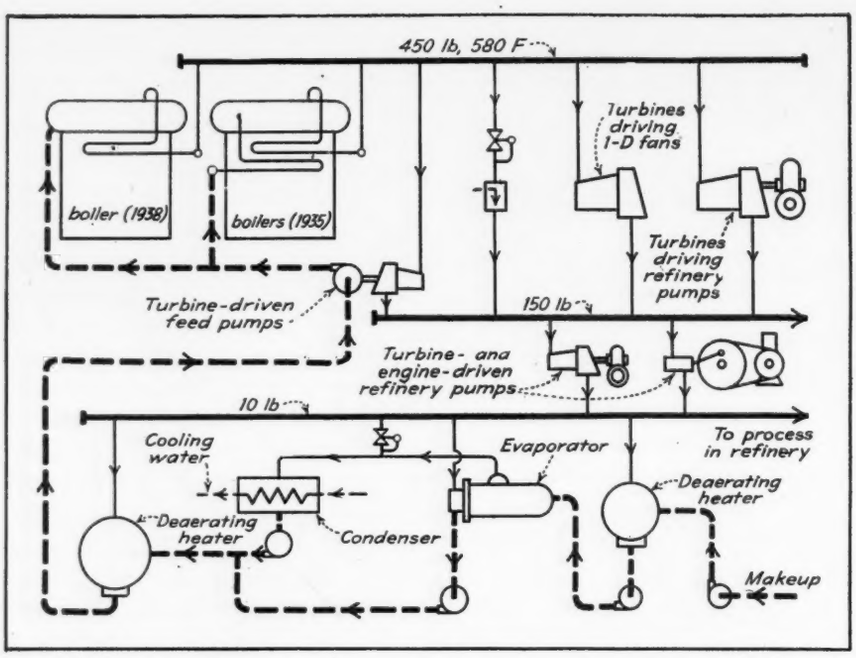
When the new boiler and the seventh refinery circulating pump were added in 1938, the capacity of the evaporator condenser was increased about one third by extending the shell and adding tube surface.

Feedwater System

The feedwater system of this plant is unusual. Makeup goes first through a zeolite softener and a small deaerating heater to the evaporator. The evaporator condensate, together with any spillover 10-lb steam condensed in the evaporator condenser, is pumped to a large outdoor storage tank. Here some of the oil separates out. The water is then pumped through a sand filter to a second storage tank, where the last traces of oil are removed. To insure



Seven of these geared 330-hp turbine-driven process-water pumps are the primary by-product-power load in the 450-lb—150-lb range



Steam generates pumping power in two expansion ranges: 450 to 150 lb and 150 to 10 lb. Water treatment and water-storage system is not shown

maximum oil separation, water enters both tanks at the top.

Makeup, as required to maintain water level for boiler feed, is pumped from last tank to a second and larger deaerating heater.

Boiler and Equipment

As already indicated, the new integral-furnace steam-generating unit operates at the original plant steam condition of 450 lb and 580 F. Like the boilers installed in 1935, it is oil and gas fired. Heating surface of the new boiler is 4203 sq ft and furnace volume 1691 cu ft.

Side walls are of the Bailey stud-tube type. Rear wall is refractory protected by bare water-cooled tubes. The water-cooled floor is of straight tubes covered with brick, tile and crushed brick. An inverted loop superheater (one gas pass and one steam pass) behind a bank of generating tubes superheats the steam 100 degrees.

The 3960-sq-ft welded tubular B & W air heater is on the side of furnace and boiler. Gas flow is 2-pass through tubes, first up then down. Air flow is single-pass across tubes.

When this unit first went into operation, sulphur in the flue gas from refinery fuels caused corrosion in the cold end of the preheater. This has been eliminated by a bypass which jumps the entering air over the first few banks of preheater tubes.

Other boiler-unit equipment includes six Diamond automatic-valve soot blowers and three Peabody combination gas and wide-range oil burners. Boiler-auxiliary equipment installed at the Wilshire Oil plant includes the following:

One—Induced-draft fan, Sturtevant. Single width, single inlet, driven by Elliott steam turbine.

One—Induced-draft fan, Sturtevant Double width, double inlet, driven by Elliott steam turbine.

One—Bailey feedwater regulator.

One—Bailey type-K35 temperature recorder showing temperature of flue gas entering and leaving air heater and of air leaving air heater.

One—Bailey type-D36 boiler meter, recording steam flow, air flow, and superheat temperature.

One—Bailey type-P5F Multipointer, indicating:
forced-draft fan pressure, wind-box pressure, furnace-draft pressure, air-heater inlet pressure, air-heater outlet pressure.

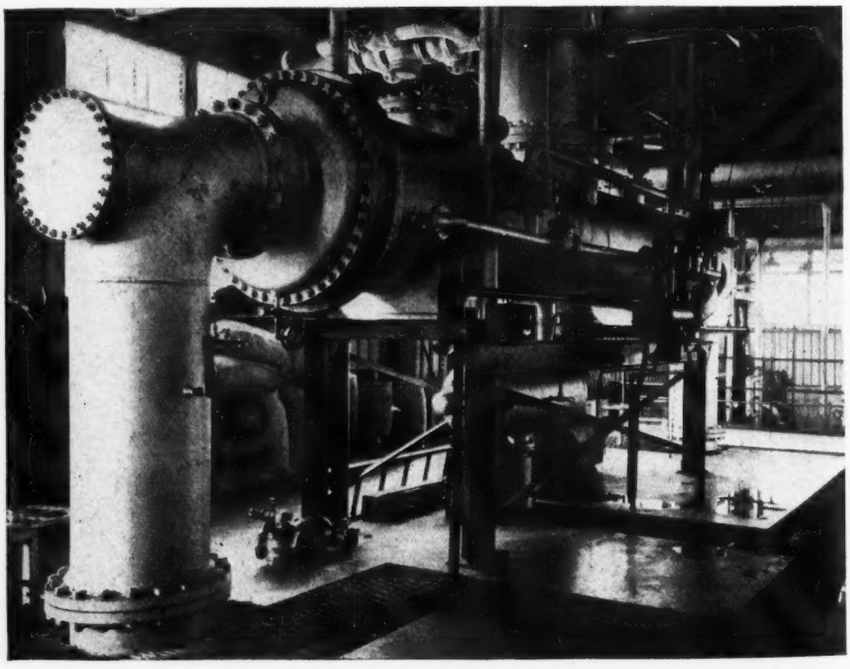
One—Complete Bailey air-operated automatic combustion control, maintaining a steady steam pressure, proper air-to-fuel ratio and a predetermined furnace draft.

Fuels burned in this plant include refinery residual oils and gases and high-quality natural gas (mostly Kettleman Hills, 1200 Btu). Cost of fuel per million heat units is extremely low. In addition, the new boiler shows over-all efficiencies (on *net* heat value) of around 87%. For these and other reasons, the over-all cost of steam at this plant is only about 17 cents per thousand pounds, including fuel, labor, supplies, repairs, and depreciation.

Heat Balance Good

From the angle of steam use, the heat balance is nearly perfect, since very little steam passes to condenser or to atmosphere and since large quantities of byproduct power are generated in the form of pumping load.

The information here presented was obtained by a POWER editor visiting the plant, with the cooperation of W C Hemphill, chief engineer of Wilshire Oil at Norwalk.



Condenser takes vapor from evaporator, also excess 10-lb steam over process requirements

LETTERS FROM A TURBINE SPECIALIST

No. 1—On Custom-Built Turbines

By F S KOHL and E V POLLARD
General Electric Co, Lynn, Mass.

Turbine Specialist
District Office

Dear Mr Specialist:

In your speech last week at our local Plant Engineer's Club meeting, you were discussing "Industrial Turbines Rated 500–7500 Kw". As I recall, you said something about *thousands* of different turbine designs being available just for these units.

That statement is hard for me to believe, even though I know that you would not have made it unless prepared to prove it. As a personal favor, I would appreciate your explaining this to me. Why do you have so many designs? Of what do these designs consist and how do you maintain any degree of standardization with such diversity?

Very truly yours,
Engineer

Dear Mr Engineer:

My statement regarding the number of turbine designs could just as well have contained the figure hundreds of thousands, or even millions. In fact, without stretching my imagination too far, I can visualize an infinite number of designs.

To get at this, let us consider the variations that may be encountered in the major items affecting any turbine design. I am listing some of these:

Rating—We have 14 standard ratings from 500–7500 kw inclusive.

Type—Those ranging from straight condensing or non-condensing to ones involving various combinations of extraction and admission features.

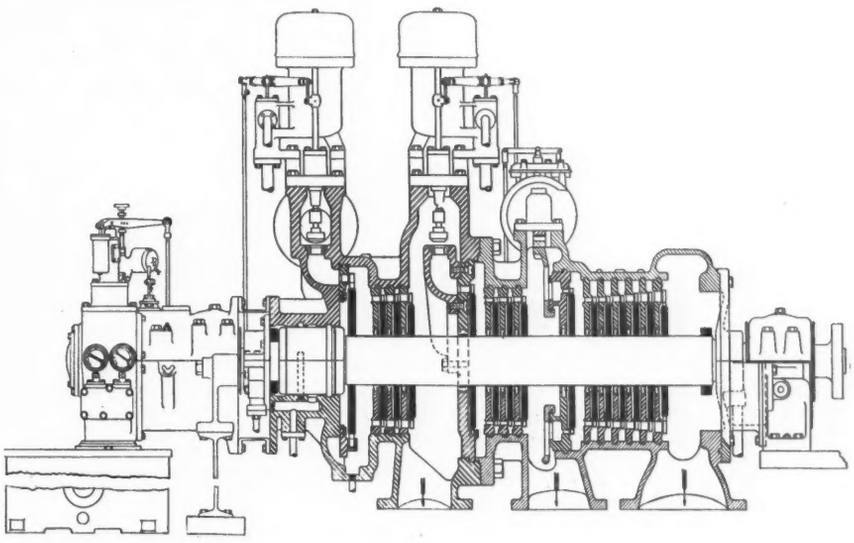
Initial Pressure—From atmospheric to over 1500 lb g.

Initial Temperature—From about 200 F to 950 F.

Exhaust Pressure—From within less than 2% of a perfect vacuum to over 400 lb g.

Extraction or Admission Pressure—From less than atmospheric to over 400 lb g.

Flow Limits—Turbines, otherwise similar, may differ in design for different maximum extraction or admission flows.



Performance—Turbines, otherwise similar, may differ in flows for which performance is favored.

Future Conditions—Initial designs may take into account future changes in operating conditions.

Turbine Speeds—Different designs are required for the different speeds used for 60-cycle, 50-cycle, geared dc and 25-cycle, and mechanical-drive units.

By the time all of these variables are taken into account in all possible combinations, you can readily see where I got my "millions" of designs.

A point to be remembered is that in spite of all these variables, each individual turbine is "custom built" for the specific conditions existing in the purchaser's plant. Hence, we need as many *available designs* as there are *possible designs*.

Another point. Regardless of the variables, about 80 or 90% of the designs are based on the use of standard parts. High-pressure heads, valve gears, casing sections, wheels, nozzles, buckets, diaphragms, exhausts, etc, have already been developed in a large number of graduated sizes. For a particular design the proper elements are selected, manufactured and assembled into a unit that exactly fits the requirements. As new features come into being, new parts are added to the standard line.

To give you a specific example of custom-building from standard parts, I am enclosing a drawing that clearly shows what was done for a recent 3500-kw, non-condensing, double-automatic-extraction turbine. The design steam conditions were 650 lb g, 750 F, 30,000-lb-per-hr extraction at 150 lb g, 50,000 lb-per-hr extraction at 50 lb g, and exhausting at 20 lb g. The assembly print shows approximate arrangement of details. Standard stages of a proper number, diameter and area were used to handle efficiently the energy available in each section of the turbine. Likewise the proper size exhaust, steam chests, valve gears, and other parts were selected. The shaft and barrel sections of the casing were then designed to fit the standard elements, giving a final design exactly conforming to the specified steam conditions.

Should you have an opportunity in the near future, I know that you would enjoy visiting the Turbine Shops and actually seeing these units constructed.

Sincerely yours,
Turbine Specialist

Insulated for Operators' Comfort

When the mercury is in the 90's, an extra inch or so of insulating block contributes to the efficiency of operator as well as steam generation

By A L SARGENT
The Philip Carey Co, Boston, Mass.

AN EXTRA INCH of insulation for operator's comfort brings an added touch into the boiler room as welcome as air conditioning in a southern hotel. The Louisiana Station of Gulf States Utilities Co at Baton Rouge has two new 500,000-lb-per-hr, 650-lb steam-generating units—one of the features is a 4-layer casing of boiler insulation.

Furnace waterwalls have high-temperature cement applied to a thickness of 3½ in. from the center line of 3¼-in. diameter wall tubes, followed by 2 in. of of high-temperature block and 3 in. of 85% magnesia. Outside casing is ⅜-in. asbestos-cement sheathing.

Waterwall headers and tubes have double-standard thickness of 85% magnesia, finished with a layer of ½-in. hard-finished asbestos cement, a layer of rosin-sized paper and an 8-oz sewed canvas jacket. Superheater outlet, exposed portions of drums and hot-air ducts are also insulated to a thickness consistent with the temperatures involved.

Flues and air heaters have 2-in. high-temperature block followed by 1½-in. magnesia block. Layers were applied in broken-joint construction and pointed up with hard-finish asbestos cement. A ½-in. layer of hard-finish asbestos cement reinforced with 1½-in. hexagonal galvanized wire mesh completes the job.

The boiler roof extends down around the rear steam drum and is covered with 2-in. high-temperature block and 2½-in. magnesia block finished off with No. 10 gage steel plate. Rear boiler closure has 2-in. refractory tile, 3½ in. of magnesia and ½-in. asbestos-cement sheathing as indicated in Fig. 2.

Heavy asbestos-board sheathing, such as specified for the furnace walls, requires careful field planning and measurement to secure an adequate supporting structure. Small welded-steel pads spaced vertically along the tubes on about 12-in. centers are tapped for ⅜-in. stud bolts. These rows are as near 36 in. apart horizontally as tubes and structural members permit.

Stud bolts about 8 in. long are screwed in the tapped holes and spacing accurately charted to indicate length of horizontal and vertical steel battens. Vertical battens, 3 in. by ¼ in., are continuous for as great a length as possible with ½-in. diameter holes punched on 12-in. centers unless actual field measurement requires variance from usual spacing of stud bolts.

Horizontal battens are 2½ x ¼ in. flat steel held in place at each end by a welded-on ⅜-in. square bar extending one inch behind each vertical batten. Lengths for the Louisiana unit varied from 4¾ in. to 33¼ in. and measurement in the field was held to nearest ⅛ in. A slight clearance allows for expansion.

Asbestos-lumber sheathing comes in stock lengths of 48 in. so that panels were cut 48 x 35½ in. to fit between the stud bolts. Narrower panels were cut according to field measurement. Panels this size of ½-in. material were about

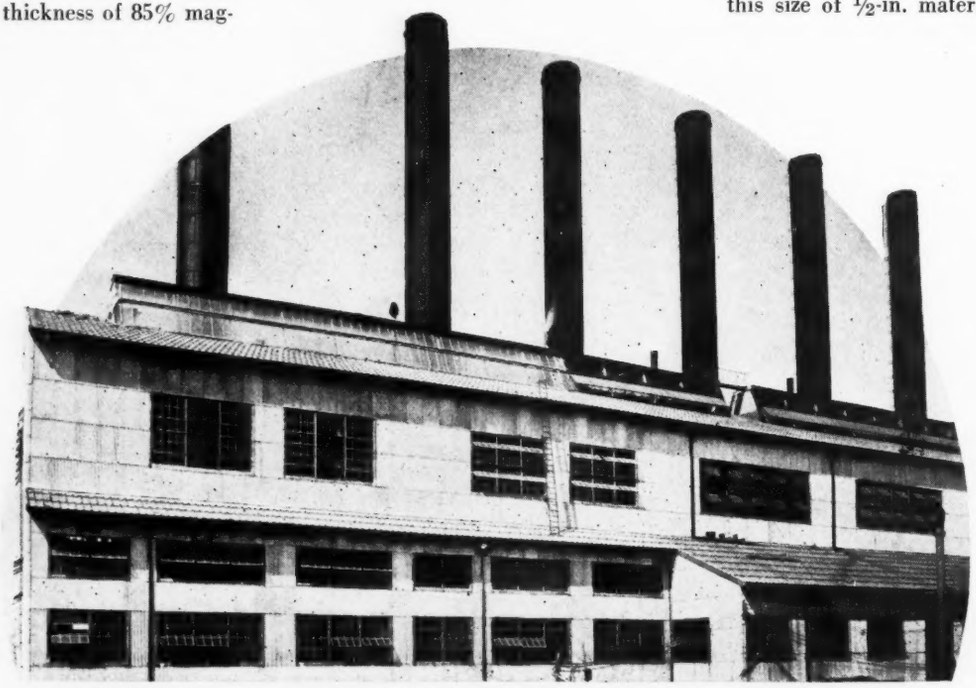


Fig. 1—Boiler-house construction allows outside air to be drawn directly into forced-draft fans so that free upward circulation of cool air improves boiler-room comfort

all one man could conveniently handle.

Erection of sheathing posed a problem of spacing the panels vertically to allow room for the horizontal-batten holding bar. First trial of spacer pieces resulted in failure because the 1-in. spacers tended to snap out of place as weight of succeeding courses of the very high walls came to bear. Cutting a recess about 1 in. wide by 6 in. long at the sides of each panel along the top provided both clearance and good bearing for the next course.

Asbestos-tape gaskets 1/8 in. thick underneath all battens gave a cushioned effect and made the casing airtight. After tightening nuts, stud bolts were cut flush and locked with a prick punch.

One of the important lessons learned was that time spent in preliminary study and careful field measurements for battens and panels costs far less than correcting errors by field welding.

With this type of construction, properly erected, a permanently attractive and durable finish neatly completes the boiler assembly, takes paint or not as desired, and keeps heat in the furnace, not in the boiler room.

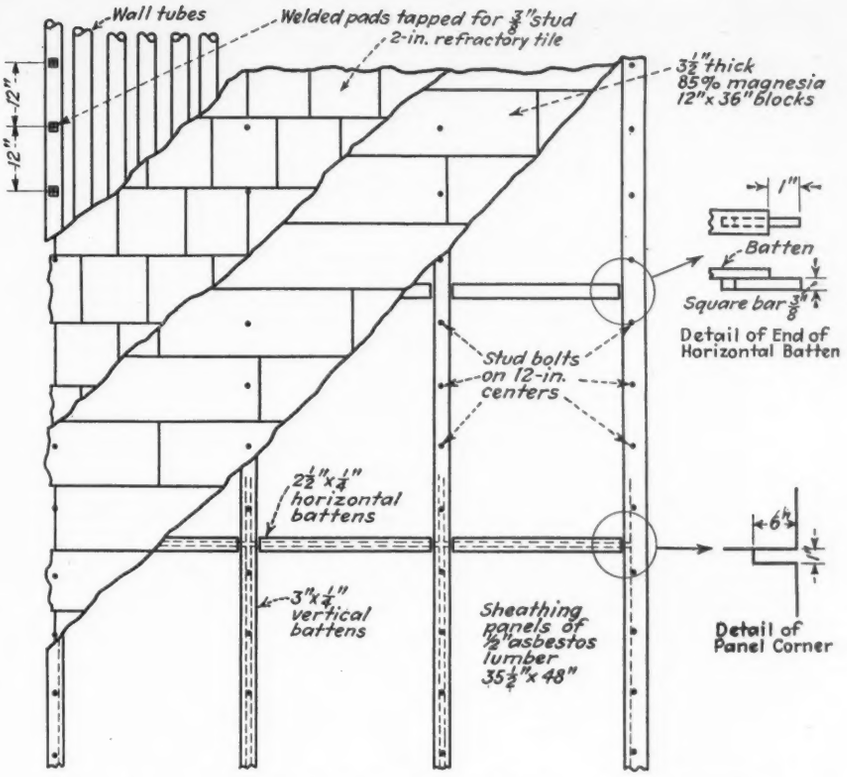

Wall tubes
Welded pads tapped for 3/8" stud
2-in. refractory tile
12"
12"
3 1/2" thick 85% magnesia 12" x 36" blocks
1"
Batten
Square bar 3/8"
Detail of End of Horizontal Batten
Stud bolts on 12-in. centers
2 1/2" x 1/4" horizontal battens
3" x 1/4" vertical battens
6"
Sheathing panels of 1/2" asbestos lumber 35 1/4" x 48"
Detail of Panel Corner

Fig. 2—Accurate panel measurement and prefabricated battens aid erection

Exhaust Lines

By L N ROWLEY

From Westinghouse we learn of what seems to be the last word in air conditioning—for a while at least. Out at the World's Fair, in the Florida National Exhibit, conditioning equipment mechanically recreates real Florida weather, complete to the fragrant odor of orange blossoms. No rain, of course.

Out of almost 20 tons of machinery in the British Admiralty's new nonmagnetic survey ship "Research" there is only about 250 lb of magnetic materials, according to "The Engineer", London. Particular interest attaches to the main engine, of 2-stroke-cycle single-acting type, which has a one-piece cast-bronze-alloy bedplate, a solid bronze flywheel, and aluminum-bronze cylinder heads and crankcase castings. Non-magnetic "Ni-Resist" iron, centrifugally cast, forms cylinder liners; aluminum cylinder blocks are cast around them.

Lin Yutang, Chinese philosopher, says, "An American editor worries his hair gray to see that no typographical mistakes appear on the pages of his magazine. The Chinese editor is wiser than that. He wants to leave his readers the supreme satisfaction of discovering a few mistakes for themselves".

The ten countries leading in developed water power, according to estimates by the Geological Survey, Dept of Interior, were, in 1938: United States, 17,949,000 hp; Canada, 8,191,000 hp; Italy, 6,000,000 hp; France, 5,400,000 hp; Japan, 4,800,000 hp; Germany, 4,000,000 hp; Norway, 3,000,000 hp; Switzerland, 2,800,000 hp; Sweden, 2,200,000 hp; and Soviet Union, 1,630,000 hp. Installed capacity doesn't give a full picture, however. In such countries as Canada and Norway which have abundant resources, electrical output of waterwheels is greater per installed hp than in countries where demand for power and lack of resources leads to installations to use water power available for only a small part of the year.

In the Burger Brewing Co's Cincinnati power plant a new 4000-sq-ft Stirling boiler, twin-retort underfeed stoker, and 150-ft brick stack have been installed under direction of A A Fette, Chief Engineer. Yes, you've guessed it—the new stack is fitted with a water spray to launder flue gas, like that designed by Mr Fette for Cincinnati General Hospital.

For the first time in England, coal will be taken direct from the mine and converted to gasoline and heavy oil practically on the spot—at a new oil-from-coal refinery, Bolsover, near Chesterfield. The refinery will guarantee a weekly output of 3400 tons from the mine and will turn each ton into 1400 lb of coalite and 21 gal. of crude oil. The whole of the latter can be converted into an equal volume of gasoline or an almost equal volume of heavy oil. Other products include fuel oil, tar acids, creosote and germicides.

Dropped in at Ford River Rouge power plant the day after Edsel Ford's son had started up the new 110,000-kw steeple-compound unit. The new machine follows general outlines of previous units, but has a hydrogen-cooled generator. As a result of the coal crisis, oil burners have been installed on all boilers at the River Rouge plant, and power engineers are pushing investigations toward making the plant independent of possible coal shortages.

Can't quite get used to thinking of steam costs that run consistently below $.10 per thousand lb—but that's what many of the new Kraft-mill power plants are doing. Even seasoned paper-mill engineer R G Seips of Crossett Paper Mills at Crossett, Ark., didn't realize what efficient steam generation from bark and black liquor would do to costs until figures started rolling in. Early cost data were looked at askance, he told me, until meters had been checked and there could be no doubt that steam cost was averaging around $0.08 per thousand, for fuel, labor and maintenance.

Building will ultimately house four engines, twice present 500-kva capacity

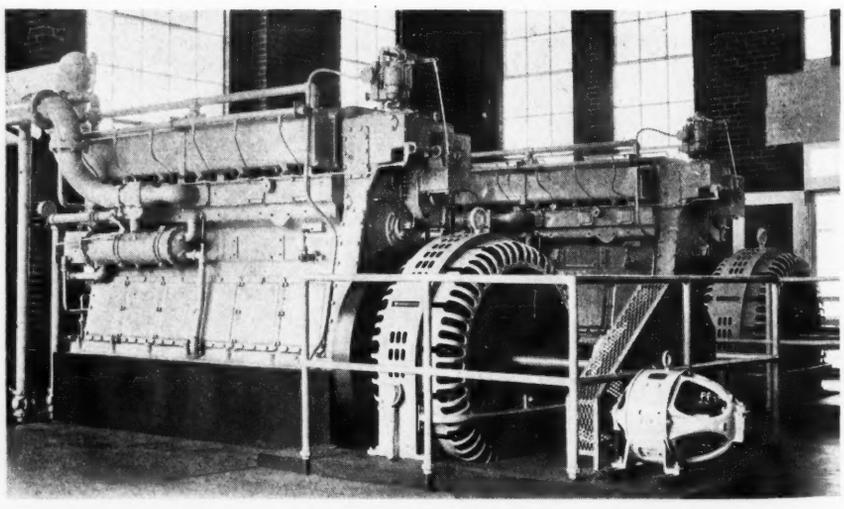
Municipal Chooses Convertible Engines

Versatile units burn gas or oil, whichever is better buy, and save money for Liberty, Texas, plant

By ORVILLE ADAMS

STARTING OPERATION with about half the meters in the city and environs connected, the new municipal light and power plant at Liberty, Texas, about 40 miles from Houston, represents the end of a long struggle against engineering and economic difficulties. A loan of $100,000 (to be paid out of earnings) and a PWA grant of $27,000 enabled the city engineer to start construction late in 1938 and bring it to completion in April of this year. Using convertible gas engines to take advantage of shifting fuel values, the new plant represents sound modern practice.

The first two units, Cooper-Bessemer convertible engines rated at 300 hp, drive 250-kva, 400-rpm, 0.8-pf engine-type Westinghouse generators, with V-belted exciters. Engines are equipped with special alloy pistons and Cook hammered piston rings. A Pickering governor, without relay, holds speed. Starting air comes from a Quincy compressor, motor-driven.



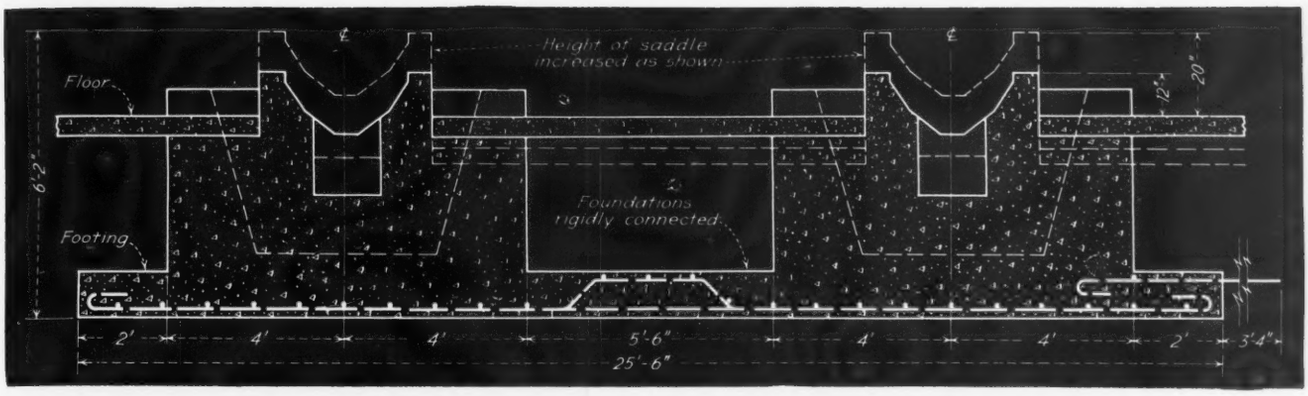
Changing liners and pistons and replacing spark plugs with injection units converts these engines from gas to diesel operation

Engine Conversion

Engines can be converted to strictly modern diesel units with only a few changes. These units are designed with 11½x13½-in. cylinders for maximum horsepower, and when converting to diesel, cylinder liners are changed to 10½ in. Changing pistons increases compression from about 100 lb for gas operation to about 400 lb for diesel. Only other step is to replace ignition system with injection equipment; injection nozzles fit same openings as spark plugs. If engine were operated with 10½-in. liners when gas fuel is used, cylinder liner change would be eliminated.

The convertible feature makes necessary cylinder heads in individual castings, with adequate water-cooling spaces, provision for inspection and cleaning, and intake and exhaust valves mounted on the head. The alloy cast-iron liners are readily removable for conversion or replacement, being held in place only by the cylinder heads.

A double-circuit system with tower (furnished by Water Cooling Corp) serves the engines. Clean water circulates through regulation coils, the heat exchanger being under the tower and above the concrete sump. A deepwell, with a Peerless pump, supplies necessary raw water, and a Zeolite Engrg Co unit softens makeup for the engine circuit. Two raw-water and two soft-water pumps (all Allis-Chalmers) have bypass connections to serve either engine or both from soft-water supply.



Quicksand underlying site presented unusual foundation problems—here's how they were met

Housings adjacent to the engine-room walls on the outside cover the American air filters and provide foundations for the Maxim silencers. On both units, Alnor pyrometers, mounted on engine operating end, keep operators informed of exhaust temperature.

A Purolator continuously filters lubricating oil. Texas Co Havoline (SAE 30) is used on power cylinders. A special Cooper-Bessemer oil cooler furnished with each engine keeps down temperature of oil in crankcase circulating system. A built-in pressure pump circulates lube oil from sump tank outside engine through an oil strainer and cooler, then through crankshaft and connecting-rod bearings.

Fuel, regular unblended natural gas having approximately 1000 Btu per cu ft heating value, is furnished by United Gas Co. Gas rate compares favorably with diesel-oil costs at about 3¢ per gal. A silent chain from the engine camshaft drives a high-tension rotary magneto. A built-in impulse coupling gives full voltage when starting and kicks out at full speed. Spark plugs are in the center of the cylinder head, the proper place for a spray nozzle when operating as a diesel. The low-pressure fuel-gas regulator reduces pressure from approximately 8 oz to atmospheric.

On acceptance tests the engines met guarantees in every respect. They operated at overload without any overheating and stress, indicating design for heavy and continuous duty.

Construction of building and engine foundations presented an engineering problem because of a great depth of quicksand found to begin 4 ft below the surface at the plant location. Depth of sand ruled out piling so engineers decided to build up ground 2 or 3 ft with borrowed dirt and to use wide footings; this put as much solid soil between foundation and quicksand as possible. Engine foundations were connected together for rigidity, properly reinforced, and extended for connection to future units in a similar fashion. Footings for the brick building were likewise made shallow to avoid approaching closer than 2 ft to quicksand. As far as concrete is concerned, the cooling-tower foundation and sump rest on top of the ground. Piping is in shallow trenches since frost line is very near surface.

The engineers consider these arrangements entirely satisfactory to support the buildings and equipment. Insulating building floor from walls and foundations entirely avoids transmission of vibration. The ceiling of the power house is rigid insulation board to protect against heat from roof.

Total cost for building and power plant construction, including all auxiliaries and expenses of erecting, testing, and engineering, came to $287.00 per kw of installed capacity. When additional units provided for are installed, cost will be lowered considerably since the building is designed for twice present capacity. It is expected that additional generating units will be required in a few years when potential demand materializes.

✦ ✦ ✦

Speed-Up Improves Elevator Operation

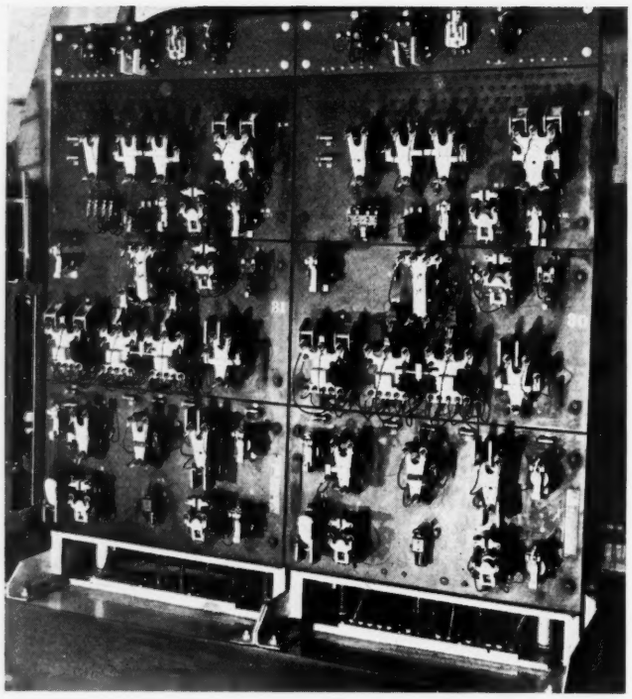
By WILLIAM DEVAUGHN
Chief Elevator Mechanic

WHEN THE 70-STORY building at 40 Wall St, New York, N. Y., was constructed, the city building code limited elevator speeds to 700 fpm. However, tower elevators Nos. 25 to 31 were provided with machines of sufficient capacity for 900-fpm operation, should the code permit later.

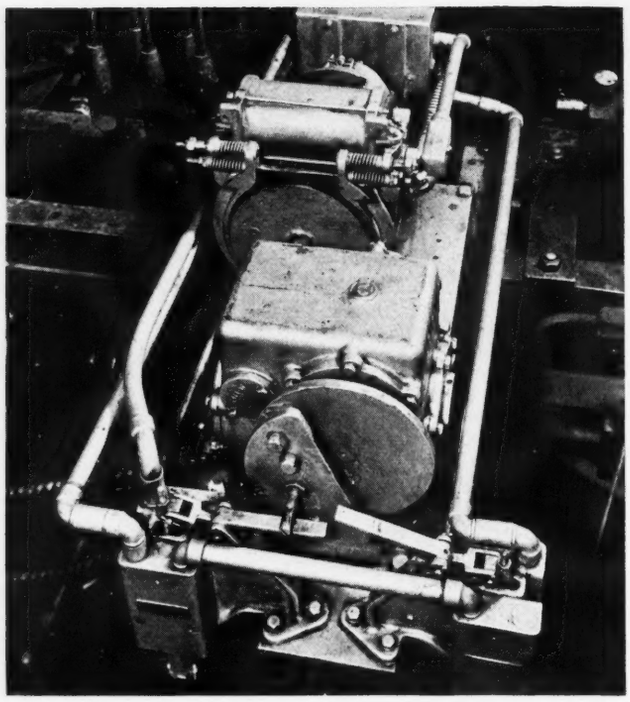
This change has recently been completed by the Otis Elevator Co, with highly satisfactory results. While the change-over was being made, we took advantage of the shutdown of each car to make other improvements in operation and maintenance.

Of the seven tower elevators, Nos. 25 to 27 run express from the ground floor to the 30th and then local to the 55th, and the other four normally run express to the 38th floor and local to the 60th. Floors above the 60th are served by 2 local cars running from the 60th.

One car was taken out of service at a time and it required about 18 days to make the necessary changes for 900-fpm operation. The main change made in the controller was to add a speed switch to give a total of five steps of control by generator-field resistance. Floor selectors were modernized by the



Additions to the control necessary to change from 700 to 900 fpm are shown at top of the panels



All wiring to the door engines is in rigid conduit, using slip-joint fittings with locknuts

addition of a new design of brush advancer and by other changes necessary to meet the conditions of high-speed operation. In the new brush advancer, stopping brushes are advanced automatically to increase stopping distance proportionately to speed of the car until maximum stopping distance is reached.

Proper overhead and pit clearance for a car speed of 900 fpm were provided in the original installation. Oil buffers in the pits were also good for the higher speed. To meet code requirements, the overspeed governors were regeared to trip at 1125 fpm, compared to 825 fpm for the former maximum speed of 700 fpm. Changes were also made in the car safeties to conform to code requirements.

Guide rails on one car were out of alignment. These were aligned and faulty joints trued up. Guide shoes on the counterweights were particularly noisy near the top and bottom. These counterweights are 18 ft long from top to bottom of the oil buffer, with four guide shoes on each side. In the two top guide shoes and the ones on the buffer we replaced the gibs with babbitt ones. In the guide shoes on the bottom of the counterweight we used wooden gibs with babbitt inserts; these we found operated more quietly than the babbitt gibs on the bottom of the counterweight.

We are also using babbitt gibs in the car guide shoes, with a shoe spring tension just sufficient to steady the car between the rails. It has been our experience that excessive tension in the guide-shoe springs serves no good purpose, and it may increase the power consumption per care mile in addition to increasing wear of the gibs and decreasing the riding qualities of the elevator car.

Door Engines

We also made several other changes to improve operation and reduce maintenance. Door-operating engines are motor driven and installed on the cars, the car and hoistway doors being operated by the same engine. We completely overhauled these engines and their motors. The wiring to these motors, which was in flexible conduit, had become oil soaked and had failed once or twice. We rewired these door operators with rubber-insulated wire protected with a slow-burning braid and installed it in rigid conduit, using slip-joint fittings with locknuts. We also put eyelet lugs with mechanical connectors on all wiring in the door-engine circuit to insure good connections.

On the car and on the main floor doors, sheaves and their bearings were worn, so we replaced the solid steel sheaves with rubber-tired ones running on ball bearings. We also replaced the buffers that take part of the shock of stopping opened doors with new ones made of a more resilient rubber. These changes permitted us to reduce the door opening and closing time to the limit of what we consider safe operation, based on our experience, which is about 1.7 sec in either direction.

To assist in identifying wires running from the hoistway terminal boxes to the cars and to the controllers, we removed the covers of these boxes and those on the cars and painted their insides white. On these surfaces we laid out the terminal blocks in the boxes and marked each terminal according to a color code and the manufacturer's marking of the wires in the control system. This identification system of marking has been followed all the way through the wiring even to the terminal boards on the controllers. Now we can go to any junction box or terminal board and immediately locate the terminal to which a given wire connects. This greatly facilitates locating faults and, when connecting in a new traveling cable, the original color code can be easily followed, because it is marked on the junction box covers.

These cars have now been in operation for several months; we get better service now with 6 cars than we used to with 7. Before the change-over was made, to maintain a fair standard of service required operating all cars continuously. Now a car can be taken out of service 2 hours in the morning and an even longer period in the afternoon for regular inspection, making minor repairs and adjustments. We have also reduced power consumption to 4.3 kw per car mile.

Boiler and Turbine in One

FOLLOWING the increasing trend towards reduced weight in steam-power machinery, the Huettner rotative boiler-turbine* combines a steam generator, with air heater and fan, and a steam turbine, with condenser, in one compact unit requiring virtually no external piping or auxiliary machinery.

Although no large units have gone into commercial operation thus far, this design has been successfully applied in several small-scale models, a section of a 100-kw unit being shown. Burners, which may use liquid or gaseous fuels, are arranged in a circle and fire into a refractory-lined combustion chamber. The boiler consists of a number of radially arranged U tubes which carry concentric fins on the combustion chamber side and volute-shaped fins on the exhaust side. Concentric fins serve merely to enlarge the heat-transmitting surface while the volute fins transfer combustion gas by centrifugal pump action.

While the combustion space stands still, the boiler tube system rotates in service. In each U tube, the ends of which are connected by ring-shaped collectors, a state of equilibrium establishes itself between the water and the steam column. Water level in the tubes varies with circumferential speed, in turn dependent on steam pressure. It is thus possible to maintain, with a constant rate of firing, a continuous steam production.

Steam Flow

Steam formed goes into the collecting chamber and passes through a circle of nozzles directly into the turbine. Reaction effect of steam flowing through the nozzles makes the boiler rotate, in a direction opposite to that of the turbine disks. The boiler shaft carries a centrifugal fan which draws in combustion air, forces it through preheater tubes and around the combustion chamber, where its temperature is further raised. Flue gas leaves boiler through stationary air-heater tubes.

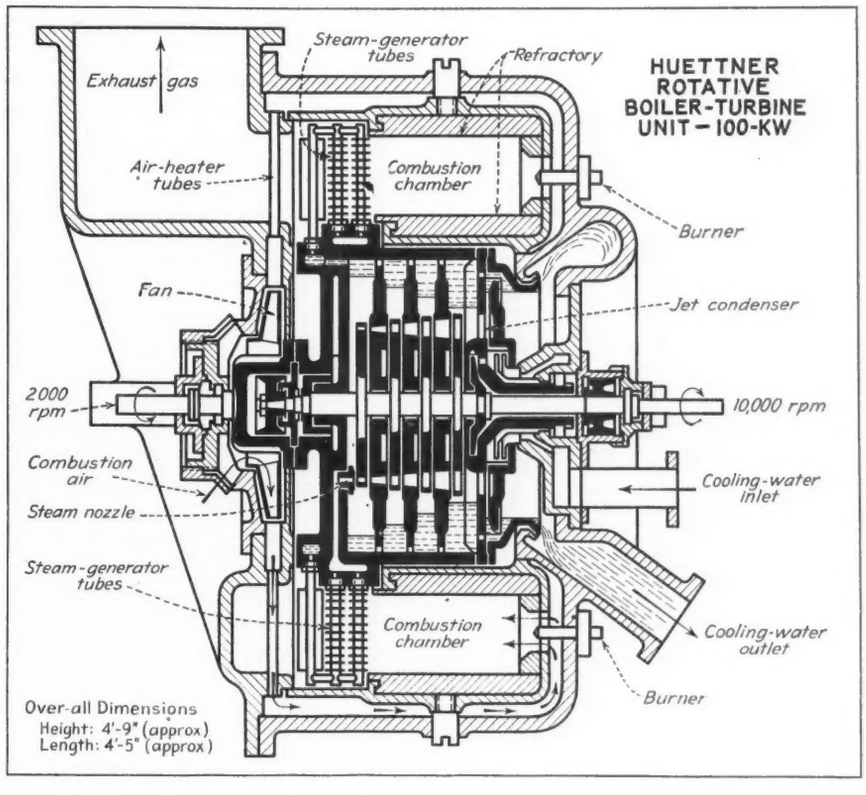
In this unit, a jet arrangement condenses exhaust steam within the turbine housing. Cooling water, introduced near the axis of rotation, has its pressure increased in the rotating-vane chambers and is projected through the exhaust space, taking with it, by entrainment, any air that may be present. In the turbine housing concentric rings form through centrifugal action, their level depending on the pressure staging. Excess water flows back over the rim of the water chamber.

No superheater being provided, the turbine operates on saturated steam. A sort of multi-stage regenerative process heats feedwater. As amount of incoming water corresponds at all times to volume of steam used, no feed pump is required, and as condensate always flows back to the boiler, there is no condensate pump either.

At first sight this machine may seem complicated. However, it must be kept in mind that there are virtually no auxiliaries but a starting motor which brings the unit up to about 10% of operating speed. Water content is comparatively small, as the same volume of water is evaporated several hundred times in one hour. Average steaming capacity has been found to amount to 50 lb per sq ft per hr. Total weight of a 500-hp unit is estimated at about 2.5 lb per hp and that of a 2000-hp machine at about 1.7 lb per hp. Space requirements are said to be comparable to those of an electric motor of the same output.

Simplicity marks the controls as the set quickly responds to any change in the quantity of fuel, the heat stored in the mass of the unit being insignificant. Careful balancing is, of course, essential; however, no difficulties in this respect have been evident, because circular sections prevail and level of water in different spaces is automatically kept uniform. Circumferential speeds depend, as has been shown, on the operating pressure: with 480 lb a speed of 360 fps would obtain. To avoid feedwater losses, stuffing boxes on the turbine shaft must be suitably designed. The boiler automatically drains its water content when stopped.

In a range of pressures of 300–700 lb and with turbine efficiencies of 75–80% and boiler efficiencies of 85–88%, over-all thermal efficiencies of 22–28% may be expected. While no serious mechanical difficulties have been experienced with units built up to now, it remains to be seen whether satisfactory continuous service can be obtained with large-scale rotative boiler-turbine combinations, which if successful, will form a revolutionary development.



* Abstracted from "Entwicklungsaufgaben bei Drehkesselturbinen" by Fritz Huettner, *Zeitschrift des Vereines Deutscher Ingenieure*, Bd 83, Nr 14. See POWER, Nov, 1932, for article describing Vorkauf rotative boiler-turbine unit.

Hydraulic Couplings Control Feed-Pump Speed

By HAROLD SINCLAIR
Managing Director
Hydraulic Coupling & Engrg Co, Ltd
Isleworth, England

ADJUSTING THE SPEED of centrifugal feed pumps to control water flow to boilers offers several advantages. One is improved feeding of the boilers because of reduced excess pressure, particularly at reduced loads. Another is improved power-plant economy from driving the pump at the correct speed to feed the boiler against the head resulting from steam-drum pressure and friction of feed piping and heating system.

Motor-driven boiler-feed centrifugal pumps, however, usually have been operated at constant speed. Constant-speed ac motors and control for this service are simple in design and operation, reliable and low in cost. Adjustable-speed ac motors and control, on the other hand are both complicated and expensive and not well suited to large high-speed designs required for modern boiler-feed pumps. Until recently, a simple adjustable-speed drive that could be used with large constant-speed motors was not available, when the hydraulic coupling was developed.

In England, when constant-speed boiler-feed centrifugal pumps are used, in order to restrict rise of pressure when rate of feed is reduced, a pump is selected with a maximum efficiency approximately 25% beyond the specified maximum output. Therefore, when operating at full boiler load, the pump efficiency is several per cent below its maximum. When running at reduced loads, pump efficiency continues to drop and the power consumption is high.

With adjustable-speed drive, the pump can be selected to operate at its highest efficiency when delivering maximum specified output. Automatic control of the speed reduces discharge pressure at reduced loads so that the pump develops only the pressure required to feed the boiler. This results in a considerable power saving, as shown by the curves, Fig. 1.

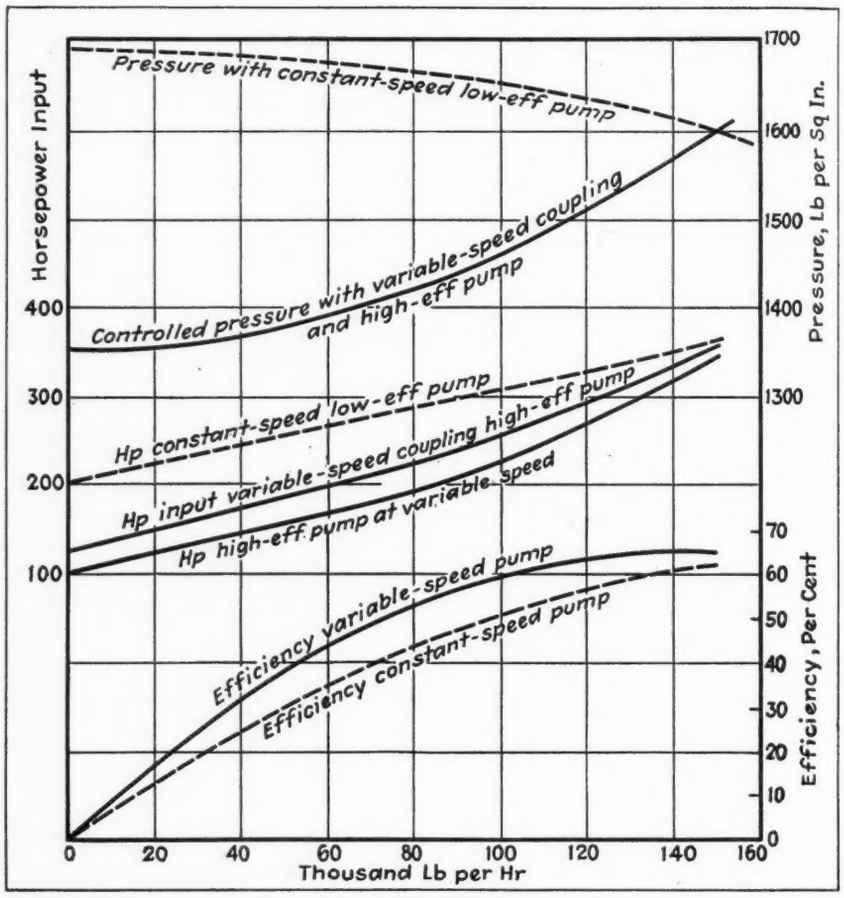


Fig. 1—Comparison between constant-speed boiler-feed pump and pump driven by constant-speed motor and variable-speed hydraulic coupling

These curves compare a constant-speed feed pump with a flat-pressure characteristic and an adjustable-speed feed pump with infinitely variable-speed hydraulic coupling and automatic control. Both pumps are rated 150,000 lb per hr when discharging against 1600 lb per sq in. pressure. They have 65.5% maximum efficiency, but the constant-speed pump, represented by the dotted curves, reaches its highest efficiency only when delivering 187,000 lb per hr. Maximum efficiency of the adjustable-speed pump, represented by the full-line curves, is attained at its specified maximum output of 150,000 lb per hr. Consequently, efficiency curve of the adjustable-speed pump lies well above that of the constant-speed pump over the whole specified operating range of load.

The head quantity curve of the constant-speed pump rises to 1690 lb per sq in. at zero output. Since steam-drum pressure is 1300 lb, there is an excess of 390 lb pressure, resulting in considerable power loss. With the adjustable-speed drive, pump speed is reduced as boiler feed decreases, so that at zero discharge, pressure is 1350 lb. This results in a substantial power saving. At 150,000 lb per hr, power to the constant-speed pump reaches 365 hp and at zero discharge drops to 250.

Two power curves are shown for the adjustable-speed pump. The upper

curve represents power input to the hydraulic coupling. At 150,000 lb per hr discharge of the pump, power input to the coupling is 357 hp, only 8 hp less than for the constant-speed drive. At zero discharge, power input to the coupling drops to 122 hp, or 78 hp less than for constant-speed operation. Power saving at full load is small but the pump seldom operates at that point. Operation is more likely to be in the range of 50 to 80% of full load than at 100%. At 80% discharge, 120,000 lb per hr, the saving in power amounts to 36 hp or, about 11.2% less than for the constant-speed pump, and at 50% load saving is 65 hp or about 23%.

The pressure of 1600 lb per sq in. specified is likely to be higher than that actually required to feed the boiler at 150,000 lb per hr. Generous allowances are made for pressure drop through piping fitting and heaters. With the constant-speed pump, excess pressure must be absorbed by throttling. When an adjustable-speed pump is used, speed is automatically reduced to supply correct pressure; therefore, at full discharge the power saving may be considerably more than shown by the curves. Other factors enter the problem that make the case more favorable for the variable-speed pump over the whole range of operation.

Fig. 2 shows a scoop-controlled hydraulic coupling as used in England for control of boiler-feed pumps driven by constant-speed motors. The input half of this coupling may be considered a pump that delivers oil to the output half to drive it as a water wheel. The casing for the coupling is attached to the input half and rotates with it. The scoop tube is pivoted at *A* on the central spindle in the stationary housing and is arranged so that it can be swung through a 70-deg arc.

Scoop-Tube Operation

When stationary, the coupling casing is filled with oil up to the level indicated. With the scoop tube fully retracted, this oil forms a ring around the inside of the casing at normal motor speed, leaving the working circuit between the two halves of the coupling empty. Moving the scoop-tube end into the oil ring transfers fluid into the working circuit, and the output half of the coupling picks up speed. Its speed depends upon the amount of oil put into the working circuit. When the coupling is full, both halves will run at practically the same speed.

A certain amount of oil leaks continuously from the coupling working circuit into the casing. This is picked up by the scoop tube, discharged through a cooler and returned to the working circuit. Control of the scoop tube, and consequently the output speed of the coupling, may be either manual or automatic. Proper division of load between several pumps of different characteristics operating in parallel can also be maintained automatically by control of the hydraulic couplings between the pumps and motors.

Because of the large power frequently required for boiler-feed pumps, type of coupling in Fig. 3 is used in the United States. This design is similar to Fig 2, except that a gear pump increases and decreases quantity of oil in the coupling to control output speed. In the design, Fig. 3, the scoop tube is stationary and serves only to circulate the oil in the coupling through the cooler, as indicated by the arrows. All oil except that required to be in the coupling for a given speed is stored in a sump in the base of the coupling.

If the control calls for an increase in speed, the pump is run in a direction to take oil out of the sump and put it into the coupling working circuit. To decrease the output speed of the coupling, the pump is caused to rotate in a direction to take oil from the working circuit and discharge it into the sump. With some types of control the oil pump runs continuously and the quantity of oil in the coupling, and consequently the speed, is regulated by control valves in the supply and discharge lines.

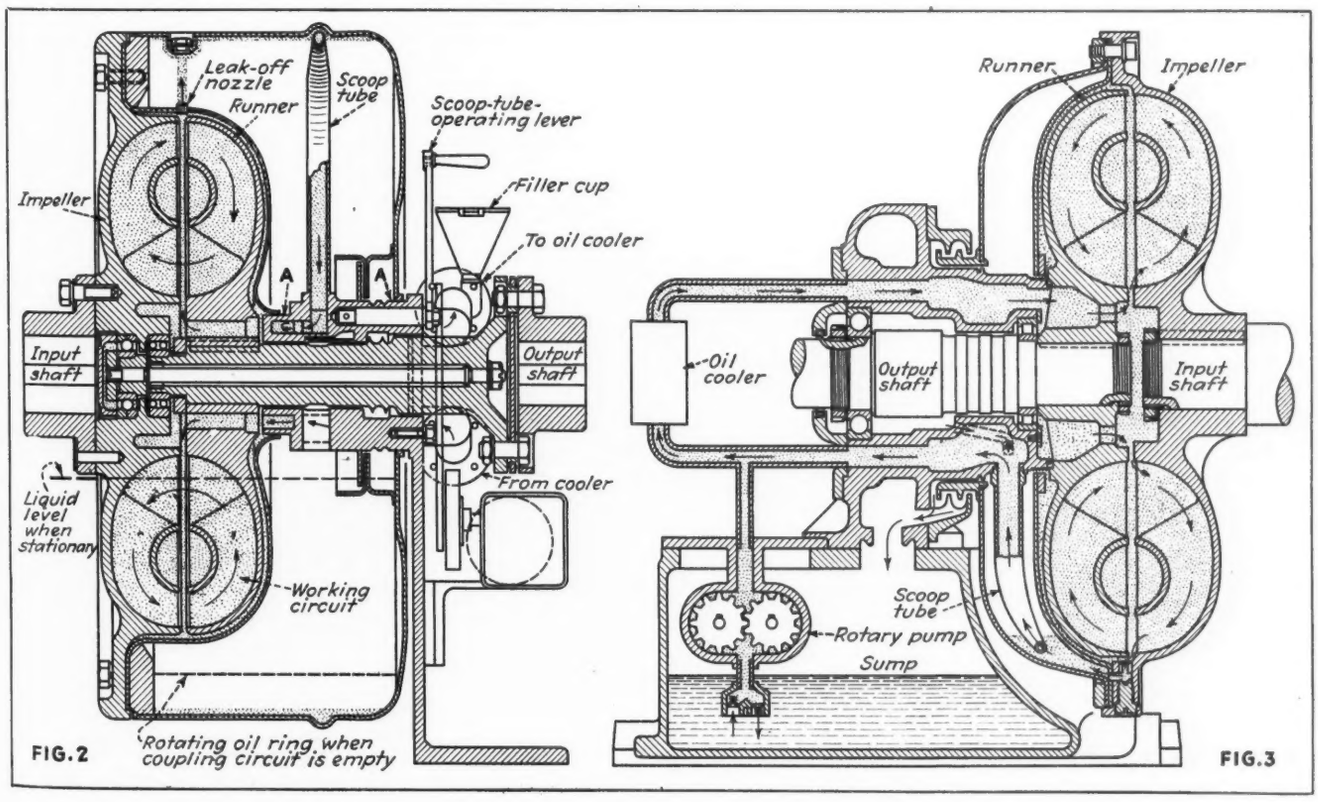


Fig. 2—Cross-section through hydraulic coupling using an adjustable scoop tube for speed control. Fig. 3—Cross-section through hydraulic coupling in which output speed is controlled by a combination of fixed scoop tube and small gear pump

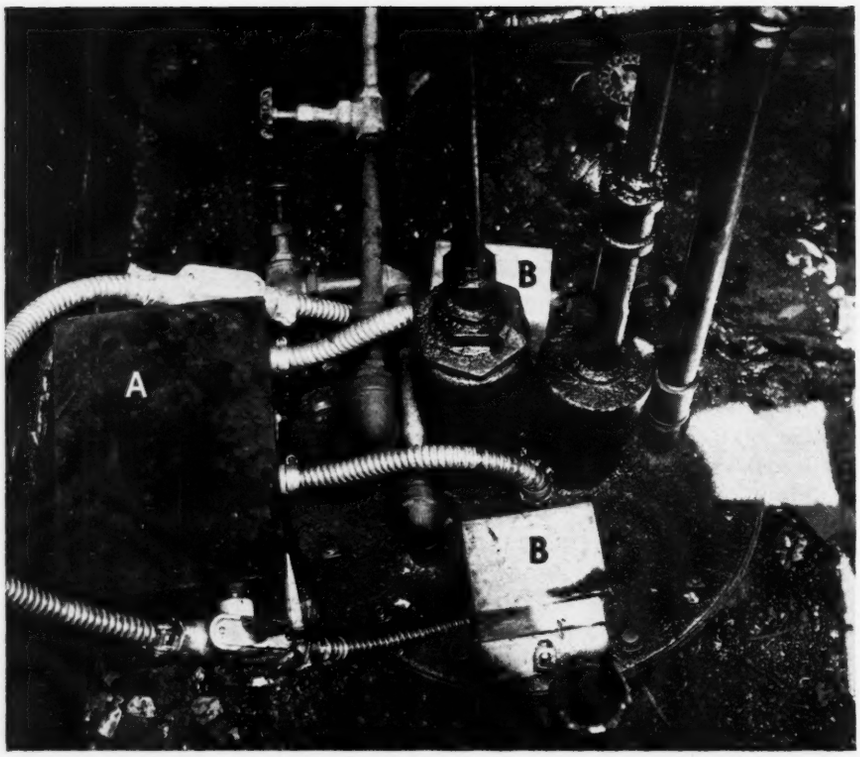


Fig. 1—Suction and return oil lines in tank manhole cover. Box A contains control operated by thermostats in the oil; boxes B are for the heater terminals

Electric Heat Saves

By C J SODERGREN, *Baltimore, Md.*

SOMETIMES AN INQUIRY about applying electric heat seems ridiculous on the surface. Such, for instance, was the call received from a plant engineer who wanted to maintain Bunker C fuel oil at near-combustion temperature in the entire circulating system supplying various industrial heating units in his plant. Investigation revealed these conditions:

The plant was supplied from a circulating oil line connected to a main tank. At points along this line, tap lines fed individual oil burners for heating dryers, and other equipment. The main oil line, 1.5 in. in diameter and about 450 ft long, was heated normally by a steam line paralleling it, both enclosed in the same insulating jacket. The fuel-oil tank, below ground and uninsulated, had approximately 10,000-gal. capacity. Depth of oil in the tank varied between 2 to 8 ft.

The coal-fired heating boiler was normally operated continuously because the fuel-oil tank was so far away that it was almost impossible to supply sufficient heat to it to get the oil started after a shut-down. It was, therefore, necessary to keep steam up on the boiler at all times, with consequent added fuel, maintenance and labor costs. Business was slow, the plant ran only three days per week, and shut-down costs were high. This made automatic electric heating of the oil line desirable if it could be done economically, so that the boiler could be shut down in summer.

Heating the oil in the storage tank, which was 8.5 x 24 ft, seemed to offer the most difficult problem, so we started there. To heat no more of the oil in the tank than necessary and thus reduce heating cost, we placed a sheet metal cylinder 18 in. in diameter in the tank. This cylinder, open at the top and bottom, made a snug fit in the top of the manhole and extended down to within about 6 in. of the tank bottom. By putting the heaters in the cylinder only, oil contained within it would be heated, assuming normal heat losses through the cylinder.

Our estimates showed that about 5.5 kw would be required to heat the oil in the cylinder and that the heat losses in the oil line would amount to about 5 kw. Because of the difficulties involved in supplying heat to the line to make up the losses, we decided to do all heating in the tank. We therefore selected two 5-kw General Electric 230-volt strip heaters. As these were to operate on 236 volts, they would produce the estimated amount of heat required.

To install the heaters near the bottom of the cylinder, where they would always be immersed in oil, they were formed in a helix as shown in Fig. 2. Standard heaters were ordered with special unheated lengths 108 in. long on each end, which gave a total length of 329 in. for each heater. The heater portion of each unit was formed into a helix about 16 in. diameter and 3 in. high. Unheated ends of each heater were brought through the manhole cover by sealed and bushed terminals. Placing one helix above the other with 1-in. separation gave a total heater height of 7 in.

Pipe connections were arranged so that oil would be drawn from and discharged inside the cylinder. Two midget thermostats with three bulbs placed near the inside of the cylinder and about 6 in. above the heaters control oil temperature.

Standard 1500- and 2500-watt heaters with steel sheaths, for insertion in non-circulating oil, were installed at each oil burner, midget thermostats being used for control. The installation has been very satisfactory and the saving in plant-operating cost during two week-end shut-downs was sufficient to pay for the electric heaters.

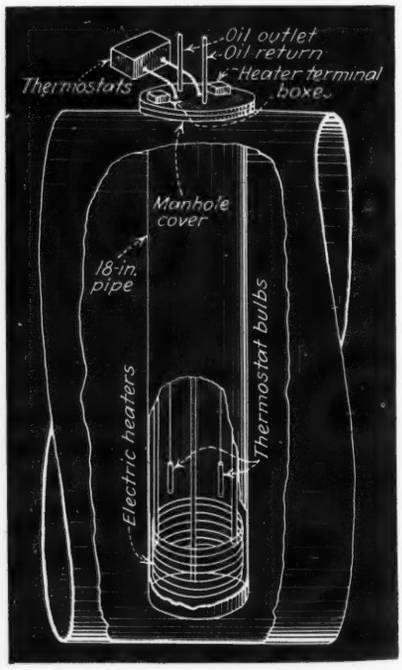


Fig. 2—Diagram of heater installation with cylinder in oil-storage tank

Gas Turbine Featured at ASME Meeting

Dr Adolphe Meyer comes from Switzerland to present new prime mover at semi-annual meeting in San Francisco. Other papers cover oil and gas firing, extraction turbines, impulse water wheels, big pump valves, cooling-tower design

Participants in power session: (left to right) F G Philo, Supt of Steam Generation, So. Calif. Edison Co; C E Steinbeck, Pacific Gas & Electric Co; H W Cross, General Electric Co (Chicago)

SAN FRANCISCO, JULY 17—Outstanding power feature of the semi-annual meeting of the ASME, held July 10-14, was a paper on the combustion gas turbine (its history, development and prospects) by Dr Adolphe Meyer, director, Brown Boveri and Co, Baden, Switzerland. To deliver this, Dr Meyer made a round trip circuit of about 16,000 miles.

Also fitting the requirements of the West-Coast region, where oil and gas are the dominant steam and power fuels, were the following papers: "Some Problems in the Burning of Fuel Oil," by A W Anderson, western district manager, Peabody Engineering Co, Los Angeles; "Characteristics of Atmosphere-Type Burners Using Natural Gas," by Prof D Howe and H G Johnson, University of California; "Boiler-Plant Performance With Natural Gas Firing," by F G Philo, supt steam generation, Southern Calif. Edison Co; "Methods of Measuring Large Volumes of Natural Gas," by Prof S R Beitler of Ohio State University and J E Overbeck of Columbia Engineering Corp, Columbus, Ohio.

Problems of hydro power and pumping were covered in: "Problems Encountered in the Design and Operation of Impulse Turbines," by Ray S Quick, chief engineer of the Pelton Water Wheel Co; "Pump Discharge Valves on the Colorado-River Aqueduct," by R M Peabody, senior engineer, Metropolitan Water District, Los Angeles; "Flow of Water in Channels Under Steep Gradients," by Wm F Durand, past president ASME; "Analogy Between Fluid Friction and Heat Transfer," by T von Kármán, Cal. Inst of Technology.

Other papers of interest to power men included: "An Improved System in the Application of Non-Condensing or Extraction Turbines," by H W Cross and E S Wells, Jr, of General Electric; "The Performance Characteristics of a Mechanically Induced Draft, Contra-Flow, Packed, Cooling Tower," by A L London, W E Mason and L M K Boelter of the University of California; "Fundamental Relationships in the Design of Cooling Towers," by G R Nance of Fluor Corp, Los Angeles; "The Economic Thickness of Insulation for Pipes in Intermittent Service," by R L Perry and W P Berggren, U of California; "Immersion Quick Freezing," by J P Ferris and R B Taylor, of TVA.

Associated events included a dinner of the Newcommen Society of England at San Francisco's famous Bohemian Club, the ASME banquet at Hotel Fairmont (meeting headquarters), a combined luncheon of ASME and the Society for the Promotion of Engineering Education, Engineers' Day at the San Francisco Fair, with an address by Herbert Hoover, and a combined engineers' dinner, at which Dr R E Ballester, Argentine Republic, presented the Calvin Rice Lecture.

Combustion Gas Turbine

In spite of the very great importance of Dr Meyer's paper on the combustion gas turbine, it will not be reviewed in detail here because this sensational development in prime movers was discussed at some length in the lead article of June POWER and will be the subject of a further article in POWER.

Very briefly the story is this: After

F T Letchfield, consulting engineer for Wells Fargo Bank and Union Trust Co. (S.F.) gave the dinner address

years of experimentation, mainly in Europe, the combustion gas turbine is now commercial equipment with a substantial number of units installed or on order (11 in the U.S. alone). As designed by Brown Boveri, these are exclusively of the continuous-combustion type, as distinguished from the earlier intermittent-combustion Holzworth gas turbine.

In its simplest form, the combustion gas turbine consists of a turbine, an axial-flow turbine air compressor and a generator, all on the same shaft. The essential requirement is very high efficiency of both turbine and compressor elements. Otherwise, all power generated by the turbine, or more, will be required to power the compressor, leaving no excess to drive the generator.

Dr Meyer indicated that present constructions without reheating or preheating would permit over-all thermal efficiencies of 15 to 18% for 1000-F inlet gas temperature, 19 to 23% for 1200 F and 22 to 26% for 1500 F. Substantial gains in over-all thermal efficiency at any given temperature can be made by using the exhaust gas to preheat the combustion air and to reheat it after partial expansion.

It was not suggested that the gas turbine will generally replace the steam turbine, but many special applications were indicated, such as power plants where cooling water is not available, where gas and oil are cheap, where a standby emergency plant is required. Dr Meyer felt that the combustion gas turbine has exceptional possibilities as a locomotive prime mover and as a top-speed prime mover for destroyers and for bomb-proof emergency plants in Europe's war-threatened area. The gas turbine, he said, has obvious applications to blast-furnace blowing, using blast-furnace gas as fuel.

Burning Fuel Oil

In his paper on fuel-oil burning, A W Anderson, of Peabody Engineering, said that Bunker C fuel is not a fairly uniform product, as many imagine. Prescribed limits are: minimum flash point 150 F, maximum water and sediment 2%, viscosity (at 122 F) between 45 and 300 sec Saybolt Furol. Within these limits, fuels vary greatly in their combustion, in tendency to deposit sludge in tanks, carbon in heaters and ash on tubes and refractories—also in ash emission from stack.

The commercial fuel oils now commonly used for boiler firing are generally the product of various cracking processes and are sold as "fuel oil"—either straight, or blended with lighter fractions. Many are classified as Bunker C. There are also certain refinery residual fuels which do not come under this classification.

Compared with straight-run residues, said Mr Anderson, cracked fuel oils have low viscosity for high specific gravity. They require less heating and have more heat value per gallon. They are easier to handle and store in cold weather. Some, however, are inherently unstable and others become unstable when mixed in tanks with other fuels, especially distillates. This may form sludge.

Unstable fuels may form deposits in fuel-oil heaters if heated too high, and may clog heaters, piping and atomizers. Greater attention, therefore, must be given oil-heating equipment, particularly temperature regulation. It appears that oils are getting more stable recently. Consumer should not set up arbitrary requirements—for example, abnormally low viscosity, which force the oil company to blend and raise price with perhaps no compensating advantage. Close cooperation between seller and consumer is important.

Burners are now available, said Mr Anderson, for capacities up to 6000 lb of oil per hour. High-capacity burners have large opening through atomizer tips, hence will run longer without cleaning. Their use means fewer burners per furnace and simpler duct work, but requires wide capacity range, particularly with automatic combustion control.

Small furnaces and high rates of heat release require more efficient burners. In Navy practice, heat releases exceeding 300,000 Btu per cu ft per hr with oil fuel is standard practice, and boiler efficiency is excellent. Mr. Anderson said that his company has worked up to 1,000,000 Btu with good efficiency.

Gas Firing at Long Beach

In a concise and practical paper based on long operating experience with the Long Beach steam station, F G Philo, supt of steam generation, Southern Calif. Edison Co, outlined the operating methods in vogue at that plant. Operators of other gas-fired boiler plants will find a copy of the complete paper of value, particularly for its detailed tabulation of the standard instructions for bringing the boilers up from cold standby, also for the chart giving losses and efficiency for various gas analyses and flue temperatures.

Originally a base-load station, Long Beach is now operated as a standby for emergency. The total capacity of 415,000 kw is equipped for oil burning, and 385,000 kw for natural gas as well. At present gas is the normal fuel. The essential requirement is boilers kept hot by burning minimum amounts of gas, yet always ready instantly to pick up and retain maximum station loads.

Gas comes to the station from three independent sources under contracts establishing a definite priority of use. This is automatically carried out by differentially set regulators. Before entering the boiler room, gas pressure is further reduced to 9 lb.

Because of the low flue temperature (300 to 350 F), the excess-air loss is not highly important. Operators therefore carry about 15% excess air to avoid any danger of the more serious loss from incomplete combustion.

Plant No. 3 boilers at Long Beach are operated with all 20 burners lighted at outputs just sufficient to carry 1% load on the main turbine, and with the combustion control on the "emergency" position. This requires manual setting of the forced- and induced-draft fans, and selection of the "completely automatic" position on the control. The balance of bringing combustion up to full fire is entirely mechanical and requires 24 sec. Under test conditions, all boilers reached maximum fan speed and fuel flow in 45 sec. The main turbine accepted 85% load instantly and reached full load in 5 min.

H W Cross and E S Wells, Jr, of General Electric, outlined a scheme of heaters which should substantially increase the byproduct power obtainable

from a given hourly flow of extracted or exhaust steam.

Under the usual arrangement, steam temperature at turbine throttle must be kept low enough to avoid appreciable superheat at the exhaust or extraction point serving process. Where higher throttle temperature is desired, it is present practice to apply a desuperheater to the process steam.

As a superior arrangement, Messrs Cross and Wells proposed two closed heaters in series. Heater *A* would be a thoroughfare heater passing the full mass of steam bled or exhausted. The process steam would be drawn off between heaters *A* and *B* and the remaining steam pass through *B*. The feedwater would pass first through *B*, then through *A*. The two heaters would be so proportioned that heater *B* would bring the water up within 10 deg, say, of the saturation temperature at the exhaust or extraction pressure, and heater *A* act merely to remove the superheat. Any slight condensation in *A* could be removed by a separator at its steam discharge.

Authors Cross and Wells worked out a comparison for a conventional backpressure turbine receiving steam at 650 lb and 596 F and supplying process with 50,000 lb per hr of saturated steam at 150 lb and 366 F. Output was 1390 kw. Raising steam temperature to 850 F, and adding a conventional desuperheater for process steam, increased the power output (same steam flow) 20.9%. Use of the proposed double-heater arrangement increased it 38.2%. Final feed temperature to the boiler figured 356 F for the original arrangement, and the same with the desuperheater. With 2-heater arrangement it was 465 F.

Required increase of boiler output was 1.8% with the desuperheater and 3.4% with the double heater.

Perfecting Pelton's Wheel

Roughly speaking, the jet impulse type of water wheel was "perfected" back about 1880 when Lester A Pelton introduced water-wheel buckets with the central dividing splitter. Yet, in fact, there has been continued progress since then and there is still room for detailed improvement, as was shown by Ray S Quick, chief engineer of the Pelton Water Wheel Co.

Recent investigations, for example, have indicated that the approach has a lot to do with the efficiency. An elbow ahead of the jet produces turbulence and this in turn gives an otherwise clean jet a "halo" of spray. Investigations showed that properly located straightening vanes on the nozzle needle will largely eliminate this spray.

In general, Mr Quick reported, the nozzle producing the best appearing and most efficient jet when tested under low-head conditions will be found best under high heads. At heads as high as 2000 ft, small jets can be made very compact and fine in appearance.

The problems of cavitation and erosion of needles and nozzle tips have been solved satisfactorily. Under ordinary working conditions nozzles and tips of carbon steel, stainless steel, nitralloy, bronze and other materials are satisfactory. Under severe conditions stainless steel of the 18-8 type is favored, using either forging or layer welding on a mild-steel base.

Cooling-Tower Design

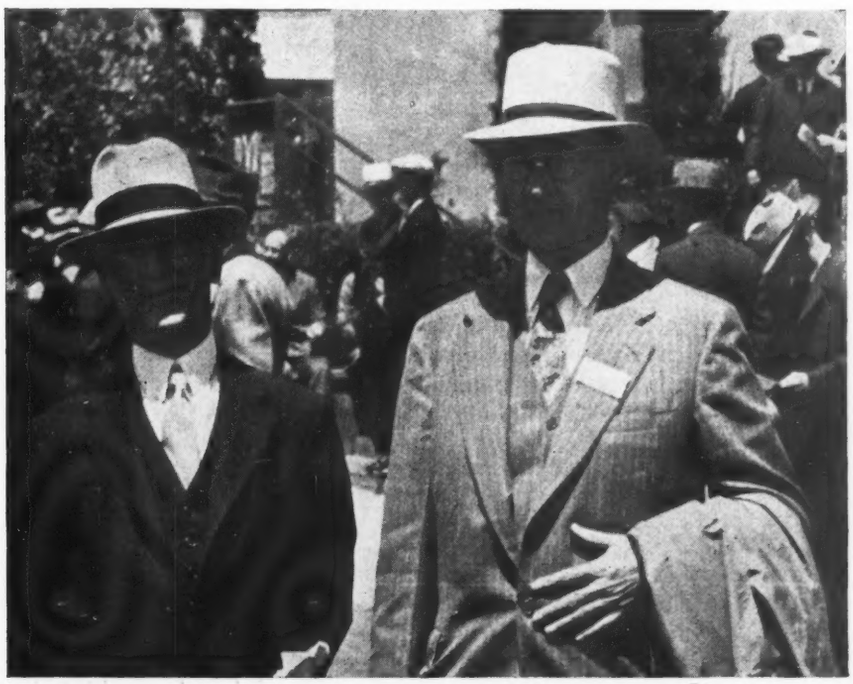
G Russell Nance, of the Fluor Corp, presented a paper giving the purchasers a basis for the evaluation of cooling towers. When the water temperature is higher than the dry-bulb temperature of the ambient air, he pointed out, water cooling occurs partly by evaporation and partly by loss of sensible heat of the water to the air. On the other hand, when the water is colder than the ambient air, cooling is produced by evaporation only, since the sensible heat transfer is in the opposite direction in this case.

Mr. Nance used the term "total cooling head" to designate an expression involving the water-temperature and the wet-bulb temperature. In general, the tendency to cool increases with the difference of these two. He used the term "approach" to designate the difference between the final water temperature and the wet-bulb temperature.

The size of a tower required to handle a given heat load varies with the performance required. It is important to specify the wet-bulb temperature, the "approach" of the final water temperature to the wet-bulb temperature, the quantity and temperature range of the water being circulated and the wind velocity.

It is generally best, said Mr Nance, to base operation on the worst atmospheric conditions experienced during the year. This results in the selection of a larger tower than is necessary for operation during the winter months, but during this time the circulation may be decreased and a compensating economy effected. By allowing a large "approach," the cost of the tower is greatly reduced. Mr Nance recommended an approach not less than 5 deg and preferably greater than 10, depending on type of power service.

Cooling ponds, Mr Nance stated, are generally economical only when a natural pond is available; otherwise excavation cost will be excessive. Spray ponds are frequently used when a large amount of space is available and the temperature range through which the water is being cooled is small. Initial cost of a spray pond will usually exceed that of any type of cooling tower, but the spray pond will generally require less pumping power than a natural-draft tower.



Two visitors from the East, Dean Dexter Kimball (left) of Cornell and ASME president A G Christie, inspect the San Francisco World's Fair

California, Here I Come

Editor Phil Swain meets engineers of the never-rain state

John Herzog, chief engineer of St. Mary's Hospital, surveys San Francisco Bay

IF YOU'VE NEVER BEEN in California, but think of it as a strange and fantastic country full of sunshine, oranges, beaches, deserts, mountains, snow and movie stars, your impression is correct but incomplete. Life here, as everywhere in America, rests on a foundation of agriculture, transportation, manufacturing—and power. Here, as in the East, the engineer is a key man, yet rarely in the spot light. He isn't part of the show; he merely makes the show possible.

California is much larger than most easterners imagine. From the northern tip of the state to the southern is as far as from New York to Florida. If California is the size of your hand, Massachusetts is slightly larger than your thumb nail.

My total time in California on this trip is nearly four weeks, just enough to touch some of the power high spots in and around Los Angeles and San Francisco. Yet what I see would fill ten times the space here available. Here are excerpts from my daily log, much boiled down:

I eat breakfast, Friday morning, June 23, as the train rolls through the fruit country. At 8:30 I debark at Los Angeles Union Station, taxi to my hotel, spend three hours with map and telephone directory, lining up my itinerary in this city of endless streets. L. A. is vast in area. Perhaps you've heard the gag about the man who started at City Hall and bored straight down through the center of the earth. He came out at the Los Angeles city limits.

To start off, I drop in on J C Kappelhoff, chief engineer of Hotel Clark, Hill St. "J C" shows me his generating plant and the new tunnel connecting it with the Subway Terminal building across the street. Will install two new 2500-sq-ft boilers in the Terminal, run steam back to the engines in the Clark plant and heat both buildings with the exhaust. (See page 120.)

Most Los Angeles offices shut down Saturdays, so I go sightseeing. City is full of automobiles; traffic control very efficient. I dine with E D Snow, who sells POWER subscriptions in L.A.

Spend Sunday, June 25, writing. Have chance to observe much advertised climate of L.A. Not as hot as New York; very comfortable, in fact. Clear, but slightly hazy. This weather report fits every day of my stay in Los Angeles, so I won't repeat.

Monday I really get down to work; make nine calls. High spots are visits to Southern Counties Gas Co and Southern California Gas Co, which, together, pretty well blanket this region with low-cost natural gas of A-1 quality (about 1200 Btu). You rarely see a coal pile around here; they make steam with oil or gas, or both, and run a lot of engines with natural gas. It's my impression that gas engines have the bulge on diesels in and around L.A., but I have no statistics handy to prove it.

Just to keep from getting too heavily sold on gas-engine power, I visit the Los Angeles Bureau of Power and Light, where they give me figures to indicate that it's mighty hard to make a gas-engine installation pay out in competition with their very low power rates. I've been told it is somewhat easier for the gas engine to make a showing outside the city limits.

Taking pity on a footsore and taxi-tired editor, Engineer-salesman G H Dieter, of Southern Cal. Gas Co, drives me around Tuesday. Naturally he takes me to a lot of gas-engine installations, but that's all right with me. We haven't had enough of these gas-engine stories in POWER, and I gather material for many a future article.

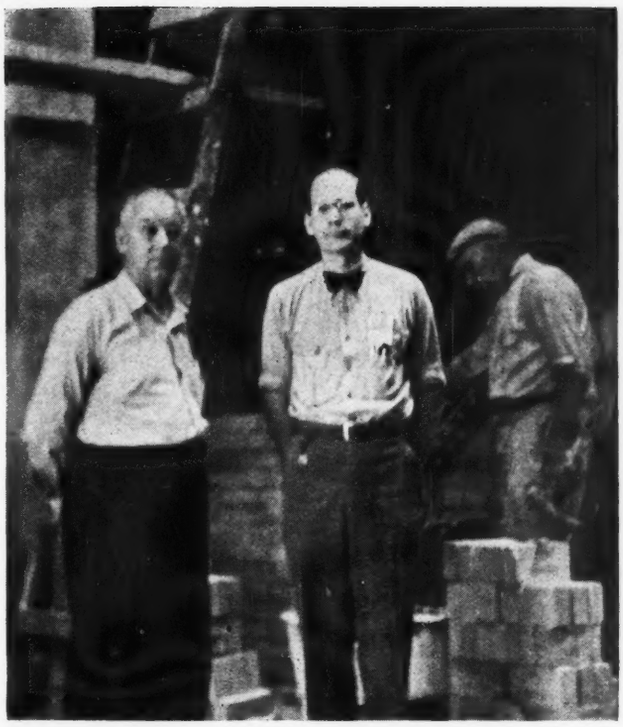
At Knudsen Creamery, chief engineer Tom Sherwin shows me his very snappy gas-engine plant generating both refrigeration and electricity. Sherwin has two 150-hp natural-gas engine sets. One drives both generator and ammonia compressor, the other compressors only. I take photographs and collect data for a short article.

Pumping Plants

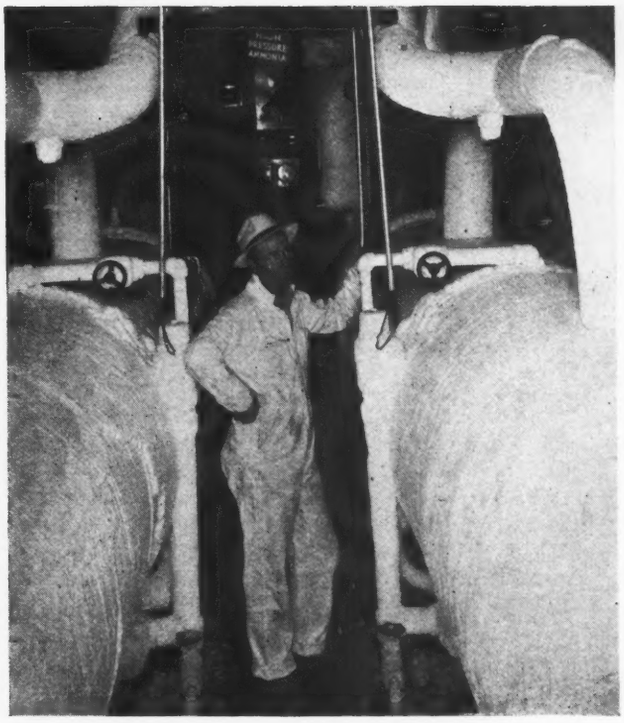
Next we inspect the "man-less" Miramonte pumping plant of the Southern California Water Co. Gate is padlocked. Dieter has a key and takes me into a plant running smoothly with no operator in sight—completely automatic. A 90-hp Worthington natural-gas engine drives a vertical deep-well pump through bevel gears. Inspector calls twice a day, looks at the instrument charts and fills in log. Story later.

Next we pay a visit to Otto B Frank, general manager of Conservative Water Co. Swell fellow! Across the street his automatic pumping plant nears completion. It's much like Miramonte, but a 250-hp engine. Neat job of installation; Frank has some good mechanics. Miramonte uses an electrically driven circulating pump to insure cooling water at no load. Conservative has a trick setup with a closed cooling system. Water from the main circulates through the heat exchanger automatically from a tap at full main diameter to one at a venturi section.

In Inglewood we visit the brand new power plant of Neals Ranch Market. Two Wakesha engines drive Master generators. Story later.



At Pioneer Flintkote, Vernon, plant engineer H B Will (left) and mechanical engineer S E Perkins will soon be operating this new 60,000-lb-per-hr, gas-fired boiler



Engineer O D Clem keeps cool with his Tropical Ice Gardens, Westward Village. Refrigerating plant consists of two 200-hp, gas-engine-compressor units

Passing the Selznick International Studio of movieland, we inspect the gas-engine powered plant of Pure Ice Co in Culver City. Engines have been in for several years; one is 54 hp, one 81 hp and one 108 hp. They drive refrigeration compressors and generators. We lunch in Beverly Hills, heart of the movie colony.

In Westward village we pause to cool off at a big outdoor ice skating rink—the Tropical Ice Gardens, a year-round operation. It takes a lot of machinery to maintain that big sheet of ice right under the Southern California sun. Chief engineer O D Clem shows me his refrigerating plant—two big horizontal units, each with two 100-hp, gas-engine cylinders and two ammonia compressor cylinders. I take photos for a picture story of this unusual installation.

Back in Beverly Hills again, we take in the power plant of the W J Sloane and J J Haggerty stores, powered by several Lycoming gas engines.

Saying "good afternoon" to lifesaver Dieter, I visit the office of the Metropolitan Water District to discuss the big pumps that will deliver Colorado River water to L.A. and vicinity, then make a call on master-model-maker Fred H Hood (see page 118), whose miniature boiler and marine engine were pictured in POWER, page 84, Nov, 1938.

Wednesday is another productive day, thanks again to Southern Cal. Gas Co. This time my guide is Engineer-salesman H H Foreman, past president of California No 2, N A P E. Another fine fellow! We pick up C A Crytser, engineer and contractor, and tour some oil-burning steam jobs on which Crytser contacted the brickwork.

At Pioneer Flintkote, in Vernon, we meet plant engineer H B Will and mechanical engineer S E Perkins. Flintkote is just bricking in a new 60,000-lb-per-hr B & W boiler, 450-lb pressure, gas fired.

At Swift & Co, Vernon, C A Crytser (left) is rebricking boiler walls for C W Keeler, plant superintendent

Next stop is Swift and Co, Vernon, where Crytser is rebuilding the party wall in a battery of 4500-sq-ft, gas-fired boilers. We meet C W Keeler, plant supt.

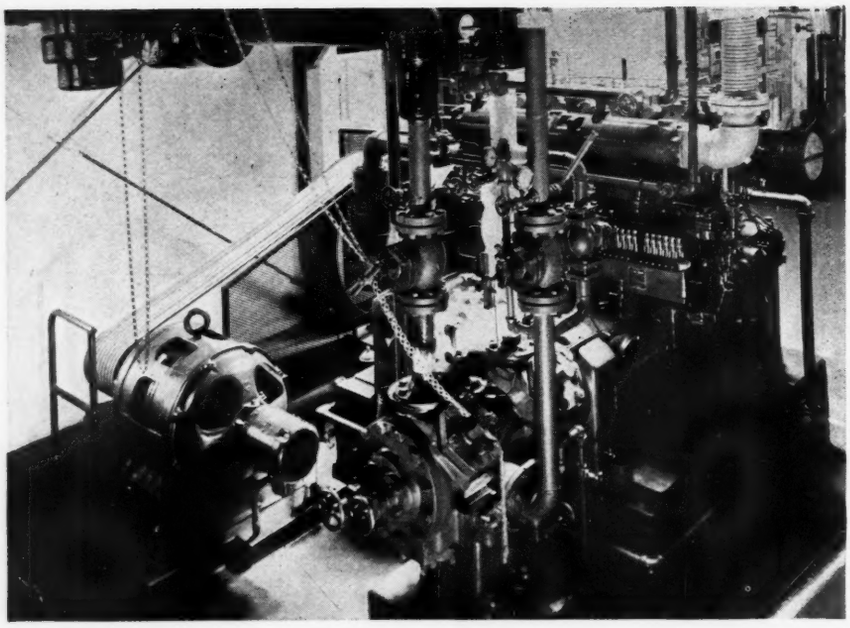
Late in the afternoon engineer Foreman drives me over to California Institute of Technology in Pasadena. We watch them polishing the 200-in. telescope mirror, visit the wonderful hydraulic lab, and pay a visit to Prof Irving Kreck, who predicts weather a month in advance for all points in the U.S., and generally hits right, I'm told.

By this time plant visits are in my blood, so when we stop at the L.A. Union Station to buy a railroad ticket, I take a quick look at the terminal's neat, gas-fired steam plant—large, spacious, clean, well lighted.

In the evening I go down town to have dinner with Robert Craig, former chief engineer at Los Angeles City Hall. He tells me about the good-old days in Scotland and elsewhere. Bob is active in NAPE and Craftsmen. Has a wide circle of friends hereabouts.

I spend Thursday, June 29, at Wilshire Oil Co, near Norwalk. With help of chief-engineer W C Hemphill, I get story on page 56. In the evening I attend meeting of Southern California No 2, NAPE, and meet a fine lot of engineers.

It takes most of Friday and Satur-



This 150-hp natural-gas engine, one of two in Knudsen Creamery (L.A.), delivers both electricity and refrigeration

day to "mop up" my Los Angeles notes. Saturday night I take the sleeper to Fresno, the first stage of a week-end trip through Yosemite national park.

Bus to Yosemite, stopping in the Mariposa grove of giant sequoia. These trees are *big!* "Old Grizzly" is 34 ft thick (diameter) at base and 26 ft thick 10 ft above ground. They say this old timer is 3400 years old, was 1500 years old when Christ was born.

San Francisco

Arrive Oakland late July 3 and ferry across Bay under Big Oakland bridge to San Francisco. The city is a wonderful sight, and so is glowing Treasure Island, man-made site of the Golden Gate Exposition.

July 4 is spent sightseeing with friends. The conviction grows that San Francisco is one of America's most delightful cities—picturesque beyond words and cool as a cucumber all summer. A few miles away in any direction the days are hot, but the thermometer rarely tops 70 F at noon in the city and you need your top coat every night.

I spend the afternoon and evening of July 4 at the Fair. Surpassed in size and in industrial exhibits by the New York World's Fair, the Golden Gate Exposition on Treasure Island is better situated and more unified in architecture. To me its outstanding feature is its really wonderful art exhibit.

Space is running short, so I shall mention only a few of my visits in and around this unique city. At the office of Pacific Gas and Electric I learn more about the three plants P G & E is installing at Martinez, Avon and Oleum. Each is adjacent to an oil refinery, uses refinery waste fuels and supplies the refinery with power and process steam. Plants will operate at 1525 lb and 950 F.

Over in booming Oakland, across the Bay, William Bessler shows me his manufacturing plant (Bessler Systems) and his forced-circulation high-pressure boilers. He drives me up the nearby Berkley Hills. Another wonderful view of San Francisco and the Golden Gate.

At the plant of Ray Oil Burner Co I see industrial oil burners in mass production. Fine, up-to-date plant. All burners are of the whirling-cup type to burn "Bunker C" or equivalent.

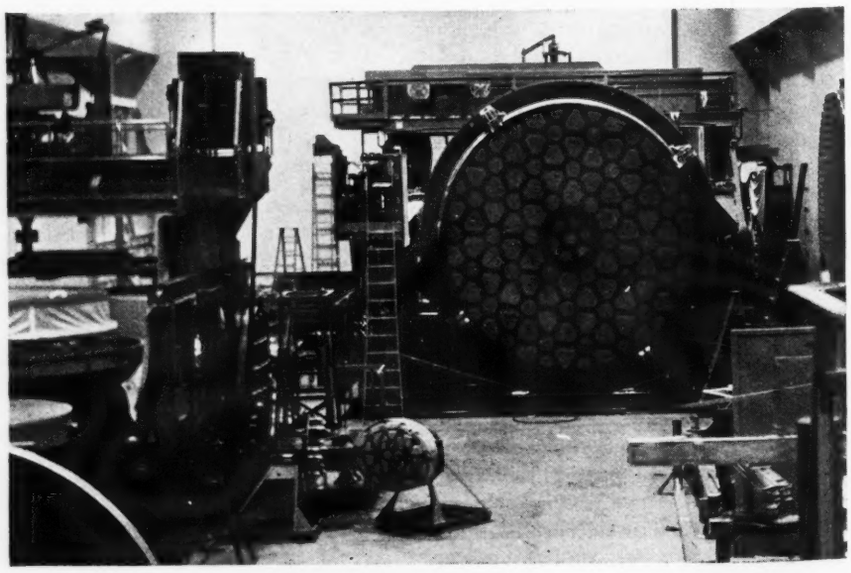
In Oakland, again, at Grove Regulator Co, Lt Grove shows me another interesting manufacturing plant and product. These fluid-pressure regulators use compressed gas as the balancing force. Grove is getting completely away from castings and forgings, uses pressed steel and steel tubing for all casing parts, regardless of pressure or service.

In the evening my wife arrives from the East to complete this trip with me. Insists I make no further reference to her in this log—she's just an unofficial observer from now on. Folks begin to gather for the ASME meeting at Hotel Fairmont—notably my old friend Adolphe Meyer and wife. Director of Brown Boveri, Dr Meyer comes all the way from Zurich, Switzerland, to San Francisco to deliver an outstanding paper on the gas turbine (See POWER, page 69).

Space is running out, so I must omit most of the San Francisco doings of this week.

On Friday, July 14, John H Herzog shows us a lot of territory along the ocean front of S.F.—also scenic spots in Marin County across the Golden Gate bridge. He takes us around the big St Mary's hospital (where he is chief engineer) and entertains us in his charming home. John is prominent in NAPE circles, past president of California No. 1 and special deputy for California. Friday night I attend the meeting of No. 1, meet president Carl Davidson, secretary George Wintus, E L Mathews and other good fellows.

[*The third and concluding installment of this travelogue will touch on things seen in the Pacific Northwest.—Editor*]



World's largest telescope mirror, 200 in., gets final polishing in air-conditioning room at Cal. Tech, Pasadena

MACHINE-MADE COLD

By L N ROWLEY
Assistant Editor

IT IS JULY, 1890. The nation swelters in a heat wave. Nerves worn raw by the heat and humidity quiver as the gnawing fear grows, "Will the ice last?"

For those were the days of ice houses and ice harvests, and that winter's crop had been only half as large as usual. As sizzling day followed sizzling day, more and more people began to ask the question, "Will these new-fangled ice machines do what they're claimed to do?"

In that one sweltering summer, machine-made cold won its spurs. Try to think what today's world would be like without mechanical cold. Better yet, think of the thousands of places refrigeration touches your daily life. It means juicy steaks, fruits in season and out, garden-fresh vegetables and sea-fresh fish. From dairy farm to your doorstep it guards your children's milk. It provides the great American treat, ice cream, and clinking ice for long drinks. Linked with the science of air, it makes the huge difference between hot summer doldrums and cool comfort.

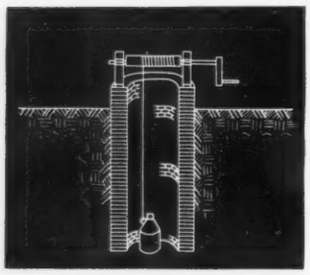
Unobtrusively, refrigeration contributes to making familiar products better and more useful—in bakeries, oil refineries, bottling plants, in printing and lithographing, chewing-gum and candy making, in the rubber industry, in brewing, in the making of drugs and chemicals, and in thousands of other vital spots in the industrial world.

Where you find refrigeration, you find also the power engineer. Refrigeration is one of the power services, one of the transformations of energy which have come to be the power engineer's special province. It is he who must know how to use today's knowledge and equipment efficiently.

To provide the essential groundwork, POWER here presents its 27th Special Section —"Machine-Made Cold". In streamlined form it summarizes modern trends in refrigerants, equipment and applications. Use it as your road map to better and cheaper mechanical refrigeration.

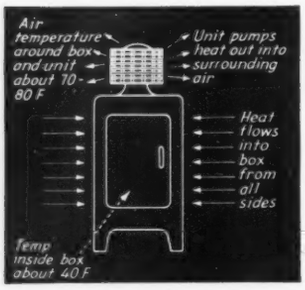
HOW MACHINES MAKE COLD

NO MATTER HOW COLD is made—and there are many ways—it depends on a few simple principles. Making cold, of course, is removing heat—an easy job when something at lower temperature is handy to absorb it. Another way of saying it is that heat runs downhill easily . . .



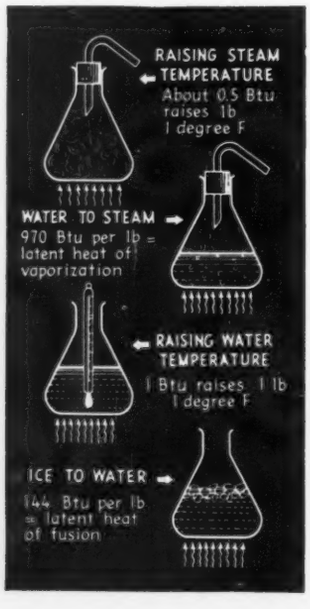
Country people still put the cider jug down the well to cool—heat flows from the jug to the cooler water until temperatures even up. Such schemes as this, and use of natural ice from rivers and lakes, provided all cooling before mechanical refrigeration developed.

Natural cooling, depending on heat running downhill, from warm body to cold body, isn't enough—the supply of cold bodies is limited. Cold-making machines do a harder job—they make heat run uphill, make it possible to cool one body with another at higher temperature. . . .


Air temperature around box and unit about 70-80 F
Unit pumps heat out into surrounding air
Heat flows into box from all sides
Temp inside box about 40 F

Domestic electric refrigerators show how this is done. Heat leaks into box, even through thick insulation. To keep inside cool, heat must be removed. But everything around box is warmer, so unit must force heat out, must pump it against temperature difference between inside of box and outside air.

This trick of making heat run uphill depends on two things: (1) what happens when liquids change to vapors and back, and (2) the way these changes of state are tied to pressure. Most refrigeration theory really rests on these two factors—let's take a closer look at them . . .

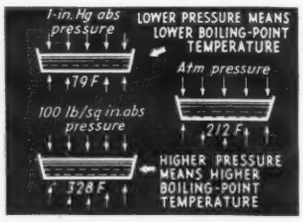

RAISING STEAM TEMPERATURE
About 0.5 Btu raises 1 lb 1 degree F
WATER TO STEAM
970 Btu per lb = latent heat of vaporization
RAISING WATER TEMPERATURE
1 Btu raises 1 lb 1 degree F
ICE TO WATER
144 Btu per lb = latent heat of fusion

Take water for example: we all know that when heated its temperature rises. Every heat unit (Btu) absorbed means one degree F rise for one pound of water. That's the way we define a Btu. But temperature goes to 212 F and stops. Heat units keep flowing into water but now go to turn water into steam or vapor. There can be no more temperature rise until all water is evaporated. When no liquid is left, we have *saturated* vapor. If we continue to heat this saturated vapor, its temperature will rise again and the vapor becomes *superheated.*

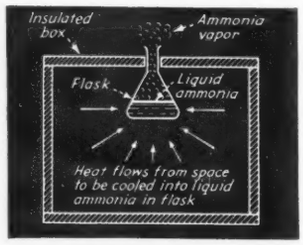
The extra heat needed to make a liquid vaporize is called *latent heat of vaporization.* Exactly the same amount of heat must be removed to condense a vapor back to a liquid. Heat needed to change a solid to a liquid (as when ice melts) is called *latent heat of fusion.* Exactly the same amount of heat is removed when going from a liquid to a solid. In none of these cases does a temperature change result from heat flow; that's why we call it "latent" heat.

Temperature at which vaporization (or condensation) takes place is directly dependent upon pressure. . . .

Water normally boils at 212 F. Put it under a vacuum, with pressure down to 1-in. Hg abs, and it will boil at 79 F. Put it under 100 lb abs and it must be heated to 328 F before it will turn into vapor. This is generally true of all liquids.

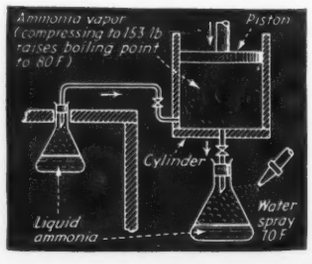


With these principles we should be able to make heat run uphill, to make cold mechanically. Suppose we take a fluid that boils at a low temperature normally—say ammonia (boiling point —28 F at atmospheric pressure). . . . Let's arrange a flask of ammonia and a box as shown. Heat will flow from warm air in box into ammonia, supplying latent heat needed for vaporization. This will keep up until liquid ammonia is gone. While ammonia lasts, this is a refrigerating system.

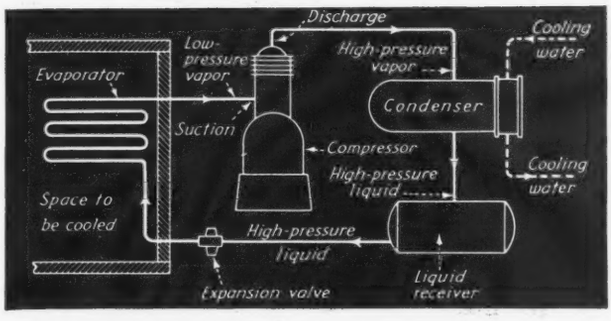


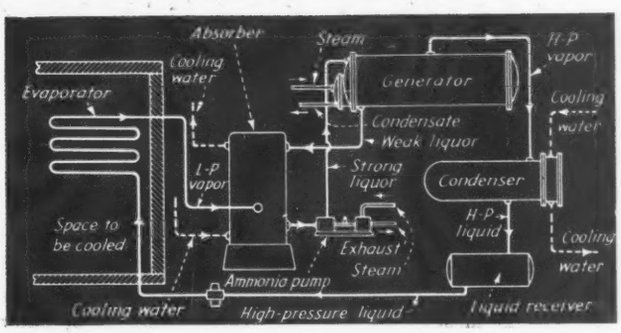
To make this crude method of refrigeration practical, we have to figure out some way of getting the ammonia back. Since ammonia boils at —28 F, under atmospheric pressure, we would have to cool the vapor down to this point before we could condense it. This means we must have a cooling medium available at a temperature well below —28 F. Such cooling mediums are rare—what we have, and want to use, are water and air, usually above 70 F. What's needed then is some way to condense this ammonia vapor at about 80 F. Now is the time to remember that temperature of vaporization or condensation depends on pressure. . . .

Suppose we compress the escaping vapor. Temperature of vaporization will rise. If we compress to about 150 lb, we can condense by using 70-F water to take out latent heat. Now we've got liquid ammonia again and can fill the flask and start all over again.



This arrangement gets around wasting ammonia but it operates intermittently and is somewhat impractical in design. First step is make the circuit complete. We replace the cylinder and piston with a reciprocating compressor and add a tank or receiver to store liquid ammonia. Finally we put a valve between the condenser in which ammonia is liquefied and the coil in which it is evaporated. This valve keeps condenser at high pressure while evaporator works at low





pressure. Diagram on next page shows complete simple system.

Let's see how this *compression system* works. Heat from the space to be cooled flows into the *evaporator*, supplying latent heat needed to make ammonia vaporize. Ammonia vapor formed in coils flows to suction side of *compressor*, which boosts its pressure. High-pressure vapor flows to *condenser* where cooling water removes latent heat and causes condensation. Liquid flows to *receiver* and then to *expansion valve*, which reduces its pressure to that wanted in evaporator.

Thus far we have talked of ammonia, because it is a common *refrigerant*, or substance used to produce refrigeration by absorbing heat in its expansion or vaporization. Many other substances are used as refrigerants; on another page their qualities and range of application is shown.

It can be seen that for any particular refrigerant, the *discharge pressure* must be high enough to permit condensing with water or air at temperatures available. It can also be seen that pressure in evaporator will depend on refrigerant and on temperature desired. This might range from 40 F for certain types of air-conditioning work down to —40 F or lower for many industrial applications.

In contrast to systems where pressure of refrigerant vapor is boosted mechanically, we have others, called *absorption systems*, which use heat to raise refrigerant pressure. For various reasons, absorption systems for commercial and industrial use have been more or less displaced by compression equipment, but they still find wide use in domestic refrigeration and in many larger-scale applications where low-cost steam is available.

There is no difference between an absorption system and a compression system from the condenser inlet to the evaporator discharge; only the method of boosting refrigerant vapor pressure differs. Absorption refrigeration relies on the ability of some liquids and solids to absorb vapors when cold and give them up when heated.

Most common combination is ammonia as refrigerant and water as *absorbent* or *solvent*. Water will take up and hold different amounts of ammonia depending on temperature and pressure. If we keep pressure steady, and raise water temperature, the amount of ammonia it can hold decreases. If we keep temperature steady and raise pressure, the amount of ammonia the water can hold increases. In the simplest terms, this is the basis of absorption refrigeration.

The sketch shows the minimum practical absorption system. Low-pressure gas from the evaporator enters the *absorber*, where it meets water at temperature low enough to absorb ammonia at suction pressure. Temperature is kept down by circulating cooling water through tubes.

The solution of water and ammonia is *aqua ammonia*. Leaving the absorber it is high in ammonia, so we call it *strong liquor*. The aqua pump forces the strong liquor into the *generator*, a tubular heater, against condenser pressure. Steam, flowing through coils in the generator, heats the strong liquor, driving off ammonia vapor at condenser pressure. Water, with some ammonia in it (called *weak liquor*), flows back to the absorber to pick up more ammonia. This cycle of absorption and release, accomplished by cooling and heating, does the same job as a compressor; it takes low-pressure vapor from the evaporator and produces high-pressure vapor at the condenser where it can be liquefied with cooling water at the range usually available, 70–80 F.

Operation of the ammonia absorption system depends on the properties of aqua ammonia, which are tabulated in most refrigeration handbooks. Other absorption systems depend on different combinations of refrigerant and solvent and some use solid substances such as chlorides of calcium, barium, and strontium, methyl and ethyl amine, silica gel and activated charcoal.

REFRIGERATING TERMS EXPLAINED

Refrigerating Effect—Amount of heat absorbed in evaporator, which is same as amount of heat removed from space to be cooled. Measured by subtracting heat content of one pound of refrigerant as it enters expansion valve from heat content of same pound as it enters compressor.

Ton of Refrigeration—Equivalent to melting one ton of ice in 24 hrs. With latent heat of ice equal to 144 Btu per lb, this means 288,000 Btu in 24 hrs, 12,000 Btu per hr, 200 Btu per min.

Refrigerant Handled—Dividing 200 Btu per min by refrigerating effect, in Btu per lb of refrigerant, gives pounds of refrigerant circulated each minute.

Work of Compression—Amount of heat added to refrigerant in compressor. Measured by subtracting heat content of one pound of refrigerant at compressor suction from heat content of same pound at compressor discharge. Multiplying work of compression, in Btu per lb, by pounds of refrigerant handled in an hour, and dividing by 2545 Btu per hphr, gives theoretical power requirements.

Coefficient of Performance—Ratio of refrigerating effect to work of compression. A high coefficient of performance means high efficiency. Theoretical coefficients range from about 2.5 to more than 5.

Horsepower per Ton—Mechanical input in horsepower, divided by tons of refrigerating effect produced. If coefficient of performance is known, horsepower per ton can be figured directly: divide 12,000 Btu per hr by 2545 Btu per hphr and by coefficient of performance.

Standard-Ton Conditions—Evaporating temperature 5 F, condensing temperature 86 F, liquid before expansion valve at 77 F, suction gas temperature 14 F. Refrigerating machines are often rated under Standard-Ton Conditions.

Head Pressure—Pressure at discharge of compressor or in condenser. "High-side" pressure.

Suction Pressure—Pressure in compressor suction or at outlet of evaporator. "Low-side" pressure.

WHICH REFRIGERANT?

NO SINGLE REFRIGERANT fits all jobs. This page tells why and the table shows how refrigerants compare.

Which refrigerant you use depends to a great extent on the so-called hazard factors—toxicity, irritant properties, inflammability, and explosiveness. These count most where large quantities of refrigerant may be released and where large numbers of people are exposed, for example, in a theatre air-conditioning system. They count least where only small quantities are used in tight fool-proof systems (domestic hermetically sealed units) or where plant is isolated and under expert supervision (ice and cold-storage plants).

These factors have been taken into account in the American Standard Safety Code for Mechanical Refrigeration, which groups common refrigerants into three classes and makes specific recommendations for the application of each. These are summarized in the table below.

Physical properties of refrigerants are tabulated below because they also affect selection. Boiling and freezing points and critical temperatures set rough limits on kind of jobs for which refrigerants are suited. Thus, CO_2's low critical temperature (88 F) means it can't be condensed at temperatures higher than that, which rules it out for air-cooled units or for places where water temperature is high. The freezing point of water limits it to high-temperature work, for producing temperatures of 40 F or above.

Use of refrigerants which must be condensed at high pressures means heavy construction for compressor, piping and condenser, and so increases cost. The table shows that CO_2 units require extremely heavy construction compared with ammonia. and that compressors for Freon-12 and other "low-pressure" refrigerants can be made even lighter than for ammonia. Equipment size depends on density of refrigerant and its ability to absorb heat units. These two factors can be combined in one index, piston displacement, which tells the cu ft of refrigerant that must be handled each minute to make one ton of refrigeration.

Cost of the original refrigerant charge and later additions and replacements becomes important in large installations. Water, of course, is cheapest, followed by CO_2, with ammonia and sulphur dioxide right behind. Power consumption is also important in large installations, but difference in theoretical horsepower requirements is slight for all refrigerants except CO_2, which requires about twice as much power per ton as ammonia.

In the light of these comments, brief study of the properties tabulated below shows why each refrigerant has a fairly well-defined field. Moderate head pressure, low piston displacement, and cheapness make ammonia the best bet for industrial applications where economy comes first. High pressure and high power consumption handicap CO_2 in spite of extremely low piston displacement, limiting it to work where safety is paramount.

Low-pressure refrigerants like Freon-12 and methyl chloride can be handled in light-weight, high-speed machines, making them particularly suited for commercial applications in standardized units. Safety characteristics of Freon-12 account for its wide use in air conditioning, but all-around higher cost restricts its use in industrial work.

REFRIGERANT ROLL CALL

Refrigerant	*Chemical Symbol*	*Hazard Factors*				*Thermal Factors*								*Operating Factors*					*Typical Applications*
		Safety Code Group [1]	*Irritant?*	*Inflammable?*	*Concentration in air to form explosive mixture*	*Condensing pressure, 86 F, lb per sq in. abs*	*Evaporation pressure—5 F, lb per sq in. abs*	*Boiling point, F (atmospheric)*	*Freezing point, F (atmospheric)*	*Critical temperature, F*	*Net refrig effect (86-5 F) Btu per lb*	*Refrigerant handled lb per min per ton*	*Piston displacement cu ft per min per ton*	*React harmfully with lubricating oils?*	*Miscible with lube oil?*	*Corrosive to metals? (alone)*	*Corrosive to metals? (with water)*	*Materials spoiled by exposure to refrigerant*	
Ammonia	NH_3	2	Yes	Slightly	13–27	169.2	34.3	−28	−107.9	271.2	474.4	0.4	3.4	No	No	No‡	Copper & alloys	Foods, textiles	General commercial work, air conditioning if indirect
Carbon Dioxide	CO_2	1	No	No	None	1039.0	334.4	−108.4	−69.9	87.8	55.0	3.6	0.94	No	No	No	Iron, copper#	None	Theatre & marine plants, institutions
Carrene — 1 (Dichloromethane)	CH_2Cl_2	1	No	No	None	10.6	1.17	105	−142.0	421.0	134.6	1.5	74.5	No	Yes	No	No	.....	Air conditioning & general commercial work, in centrifugal compressors
Carrene–2 (Freon–11) (Trichloromonofluoromethane)	CCl_3F	1	No	No	None	18.3	3.0	74.7	−168.0	388.4	67.5	3.0	36.3	No	Yes	No	No	None	Air conditioning & general commercial work, in centrifugal compressors
Freon–12 (Dichlorodifluoromethane)	CCl_2F_2	1	No	No	None	107.9	26.6	−21.7	−247.0	233.0	51.1	3.9	5.8	No	Yes	No	No	None	Air conditioning & general commercial work
Freon–21 (Dichloromonofluoromethane)	$CHCl_2F$	1	No	Slightly	None	31.2	5.3	48.0	−196.6	353.3	89.4	2.2	20.4	No	Yes	No	No	None	Rotary compressors
Dielene (Dichloroethylene)	$C_2H_2Cl_2$	2	*	.....	5–11	6.9	0.82	122	−70.0	470.0	114.4	1.75	112.6	.....	Yes	.....	.....	.....	Has been used in large centrifugal compressors
Ethyl Chloride	C_2H_5Cl	2	*	Yes	4–14	27.1	4.7	54.0	−217.7	369.0	142.9	1.4	22.6	.....	Yes	.....	.....	.....	Small units
Isobutane	$(CH_3)_2CH$	3	**	Yes	2–6	59.5	13.1	10.3	−229.0	272.7	111.5	1.8	11.5	No	Yes	No	No	.....	Small units
Methyl Chloride	CH_3Cl	2	No *	Slightly	8–17	95.5	20.9	−10.7	−144.0	289.6	148.7	1.3	6.1	No	Yes	No	Zinc, alum	None	Smaller units for general commercial work
Sulphur Dioxide	SO_2	2	Yes	No	None	66.5	11.8	14.0	−98.9	314.8	143.1	1.4	9.1	Some	No	No	Most metals	Flowers, some dyes	Household — small commercial units
Water	H_2O	†	No	No	None	0.62	0.02	212	32	706.0	1007.3	0.2	2288.0	No	No	Yes	.....	None	Air conditioning & to supply chilled water in industrial plants

[1] AMERICAN STANDARD SAFETY CODE FOR MECHANICAL REFRIGERATION — Divides refrigerants into three groups: Group 1 may be used, with minor limitations, in institutional, public assembly, residential, commercial, and industrial occupancies; Group 2 may be used, with strict limitations, in the same occupancies; Group 3 may be used only in residential, commercial and industrial occupancies, in unit systems containing not more than 6 lb. † Code doesn't list water as refrigerant, but it is probably safest. * Considered anaesthetic. ** Underwriters recommend adding odorant such as spearmint. ‡ Pure anhydrous ammonia attacks copper, but in actual practice seems to give no trouble. # Action only continues when oxygen is present.

COMPRESSORS

OF THE SEVERAL COMPRESSOR types built, the reciprocating-piston machine finds widest use, largely because of its mechanical simplicity and low cost. Centrifugal compressors, running at high speed, are particularly suited to handling large-volume, low-pressure vapors. Thermo-compressors or steam-jet boosters offer an alternative means of compression where energy in steam can be substituted for mechanical energy.

The most common type of ammonia compressor is the space-saving vertical single-acting unit. Double-acting units are usually horizontal, but vertical ones are built. Single-acting machines are more common because the valve arrangement is simpler, and no stuffing box is needed. Two typical, 2-cylinder, vertical units are shown below.

False heads carrying the discharge valves are held down solely by springs, as a safety feature to guard against effects of a slug of liquid carried into the cylinder. The piston itself is long, to act as a crosshead. Suction valves, unlike those in air compressors, are in the upper part of the piston so that refrigerant flow is from the crankcase through the piston to the cylinder.

Forced-feed lubrication is common on large compressors, but in small units, crankshaft splashes oil on bearings and oil pockets above main bearings. In the latter case, wrist pins get oil from plunger lubricators on connecting rods. An oil filter or strainer is usually furnished. Cylinder walls are lubricated by a separate sight-feed or mechanical lubricator.

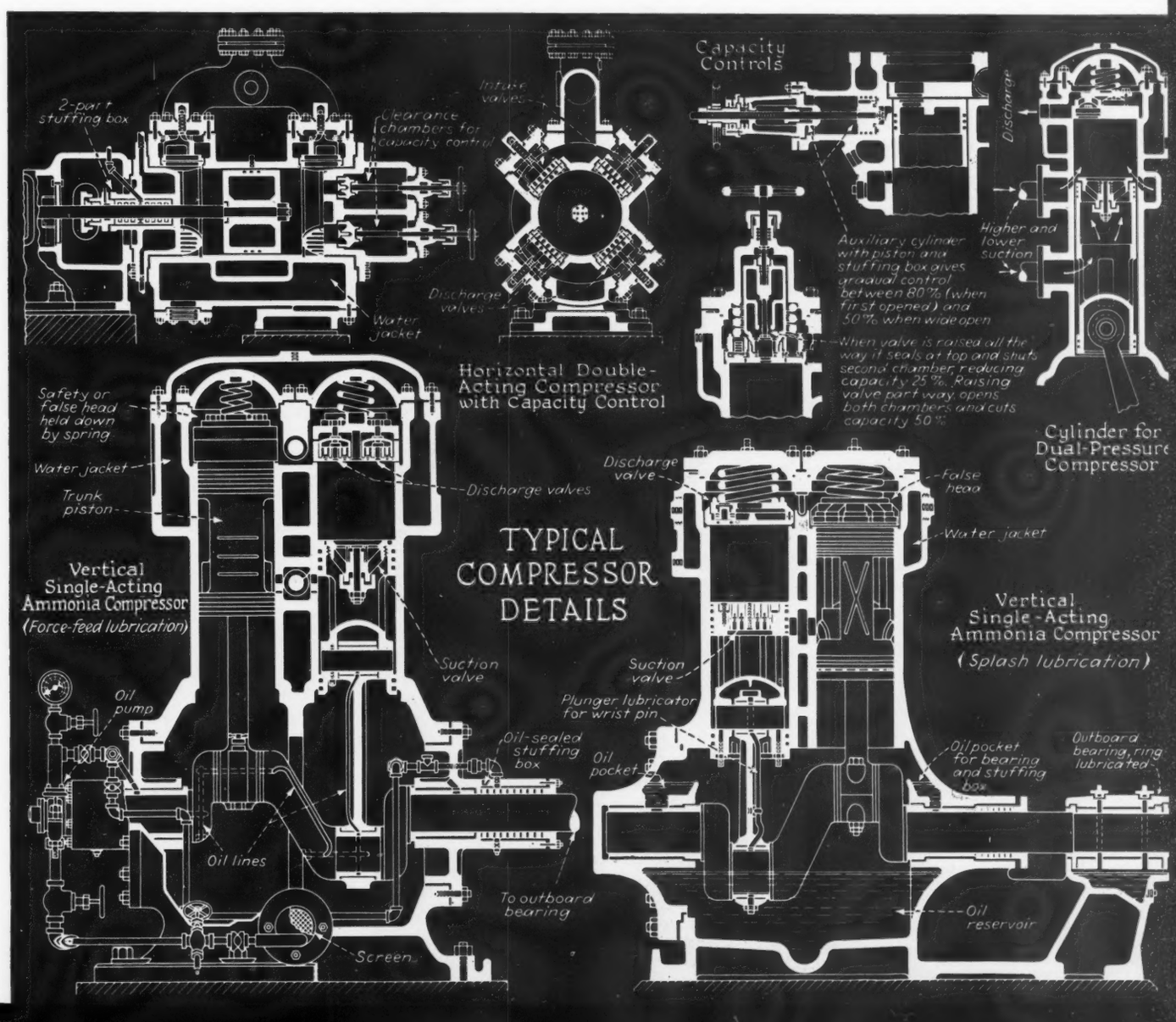
Higher Speeds

Modern vertical compressors run at much higher speeds than older types and so produce required tonnage from a lighter, smaller machine. A speed range of from 360 rpm (for 10½-in. stroke) to 600 rpm (for 2½-in. stroke) is considered good practice for direct-connected or belted units.

The section through a typical horizontal double-acting compressor shows valves arranged on cylinder walls, with discharge valves on the bottom, water-jacketed. The frame, not shown, is completely enclosed and the unit is self-oiling. Horizontal machines run at lower speeds than vertical, below 200 rpm being customary. They are built in large cylinder sizes, running up to 16x24 in. and larger.

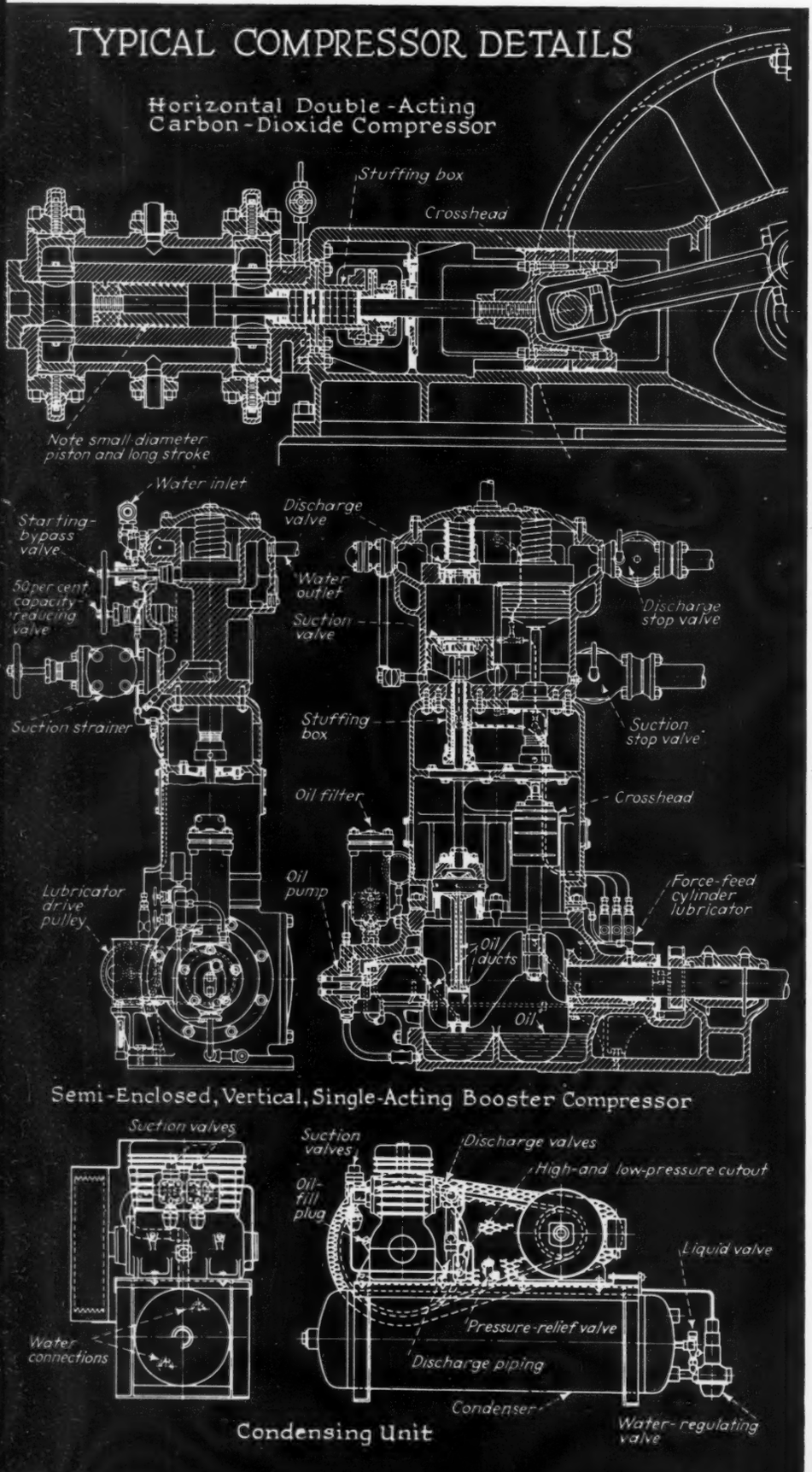
Special compressor equipment serves plants where two temperature levels are maintained, or where extremely low temperatures are required. Dual-pressure compressors permit handling refrigerant at two suction pressures. A section through a cylinder shows how low-pressure gas enters in normal way, on the down stroke of piston. Near the end of the down stroke, the piston uncovers auxiliary ports and medium-pressure suction gas rushes in, compressing low-pressure gas already there. Slow motion of the piston during this part of stroke gives time for this to occur.

Where low temperatures are required, large difference between fixed


TYPICAL COMPRESSOR DETAILS
Vertical Single-Acting Ammonia Compressor (Force-feed lubrication)
2-part stuffing box
Clearance chambers for capacity control
Intake valves
Discharge valves
Water jacket
Horizontal Double-Acting Compressor with Capacity Control
Capacity Controls
Discharge
Auxiliary cylinder with piston and stuffing box gives gradual control between 80% (when first opened) and 50% when wide open
When valve is raised all the way it seals at top and shuts second chamber, reducing capacity 25%. Raising valve part way opens both chambers and cuts capacity 50%
Higher and lower suction
Cylinder for Dual-Pressure Compressor
Safety or false head held down by spring
Water jacket
Trunk piston
Discharge valves
Discharge valve
False head
Water jacket
Vertical Single-Acting Ammonia Compressor (Splash lubrication)
Suction valve
Suction valve
Oil pump
Plunger lubricator for wrist pin
Oil-sealed stuffing box
Oil pocket
Oil pocket for bearing and stuffing box
Outboard bearing, ring lubricated
Oil lines
To outboard bearing
Oil reservoir
Screen

condenser pressure and low suction pressure causes trouble in ordinary compressors. Refrigerant temperature rises rapidly in the cylinder, making valves and cylinder walls hot, which heat incoming suction gas. This means less weight of gas handled per stroke. High temperature also causes lubricant carbonization on valves, increasing leakage already aggravated by large pressure difference. Power consumption goes up and compressor capacity goes down. Dividing compression into two stages solves this problem; large volume of gas at suction pressure is partially compressed, and then cooled before being further compressed to needed condenser pressure. Two-stage compressors may be used, but the trend seems toward separate compressors, called "booster compressors", for the low-pressure stage.

The booster compressor illustrated shows features which fit it for low-pressure work, including double-ported valves for maximum area with minimum lift, and a pipe connection between the discharge side of compressor and the stuffing box to prevent air infiltration through the piston-rod stuffing box when operating under vacuum. Booster compressors offer greater flexibility, than compound or 2-stage compressors, as stages can be separately controlled. Boosters can be added to existing plants, and with a few changes in hookup will markedly improve low-temperature operation (see POWER, July, 1938, for description of such a change).



CO_2 Compressors

Design for high pressure accounts for major difference between CO_2 and ammonia compressors. Carbon-dioxide machines are built in both horizontal double-acting and vertical single-acting (enclosed or open-frame) types. These compressors are strongly constructed and feature a relatively long stroke and small piston diameter, to reduce bearing pressures.

Other refrigerants commonly used in piston compressors of moderate size are Freon-12 and methyl chloride. Such units are not unlike ammonia machines of the vertical single-acting type, but proportioning of valves, ports and passages differs to allow for the greater vapor density of Freon-12 and methyl chloride. Since both are miscible in oil, which tends to carry over with refrigerant, some means is usually provided for returning oil to the compressor where it is separated from refrigerant.

Condensing Units

For small-scale commercial and industrial work, and particularly for air conditioning, condensing units employing low-pressure refrigerants fill a definite need. The name "condensing unit" usually applies to a complete "high-side", consisting of compressor, motor, condenser, and receiver, all mounted on a single frame or base. They offer compactness, ease of purchase and installation, and automatic operation. Widest use is in sizes below 25 tons, but condensing units can be bought up to 75–100 tons.

Speed change offers the best means of capacity control, but the cost of a variable-speed drive limits its application. Throttling flow of condensing water or refrigerant reduces capacity but wastes power. Normally, load de-

mands are met by starting and stopping machines manually or automatically. On large machines, capacity can be controlled by cutting out individual cylinders, by increasing clearance, or by a suction bypass. The illustration shows several kinds of clearance pockets, and the booster compressor shown has a suction bypass which, when open, reduces capacity 50%. Operators usually control pockets or bypass by manually operated valves. but they can be arranged for automatic control.

Centrifugal Compressors

Suitability of Carrene and water to air conditioning and to industrial applications, where water chilling or relatively high-temperature refrigeration is required, led to development of high-speed centrifugal compressors to handle these large-volume, low-compression-range vapors. Resembling multistage centrifugal pumps, they raise pressure in small steps. Most are built as units, complete with evaporators, condensers, and auxiliaries, in sizes ranging from about 100 to 1000 tons. Evaporation takes place at high vacuum and a separate vacuum pump or steam-jet ejector takes care of leakage. In water units, the evaporator is only a shell, since the refrigerant is also a cooling medium, evaporation of a portion chilling the remainder. In Carrene units, evaporators are shell-and-tube; both water and Carrene units use shell-and-tube condensers. The turbine-driven, water-vapor unit illustrated has a combined condenser for turbine steam and refrigerant vapor.

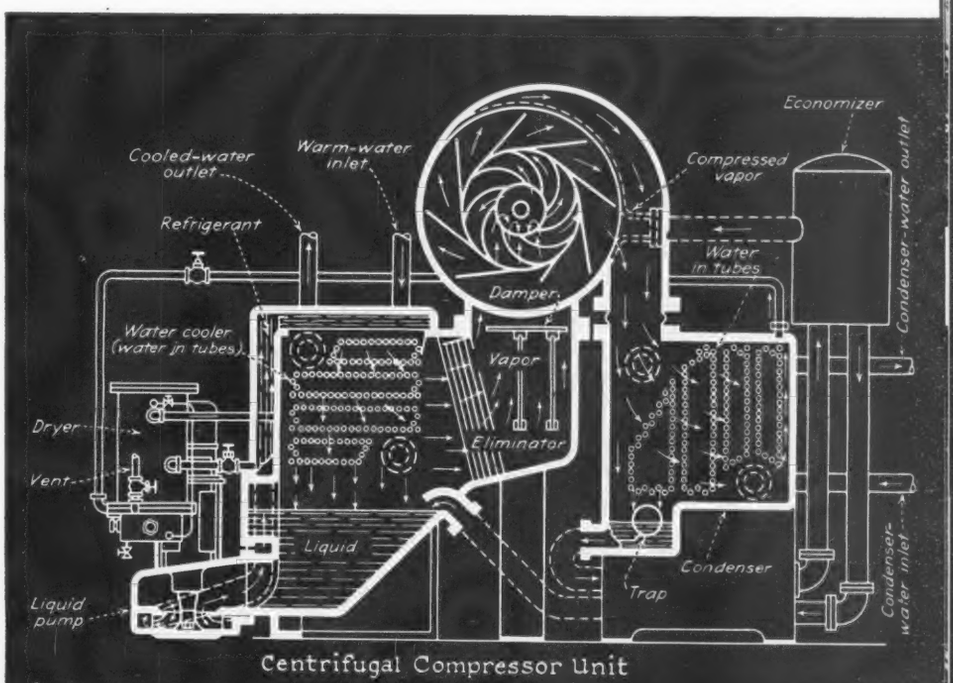
Steam-Jet Refrigeration

Steam-jet ejectors represent another way of using water vapor as a refrigerant, particularly adapted for situations where low-cost steam is available. The familiar ejector principle is employed to reduce pressure in an evaporator shell containing water. At high vacuum, part of the water vaporizes, taking needed latent heat from the remaining water, which is chilled. The vapor passes into a condenser, which may be surface or barometric. Auxiliary steam jets with inter- and after-condensers maintain condenser vacuum. Use of multiple booster jets gives capacity control by cutting jets in and out. Steam-jet units take more cooling water than compression systems because steam as well as refrigerant vapor must be condensed.

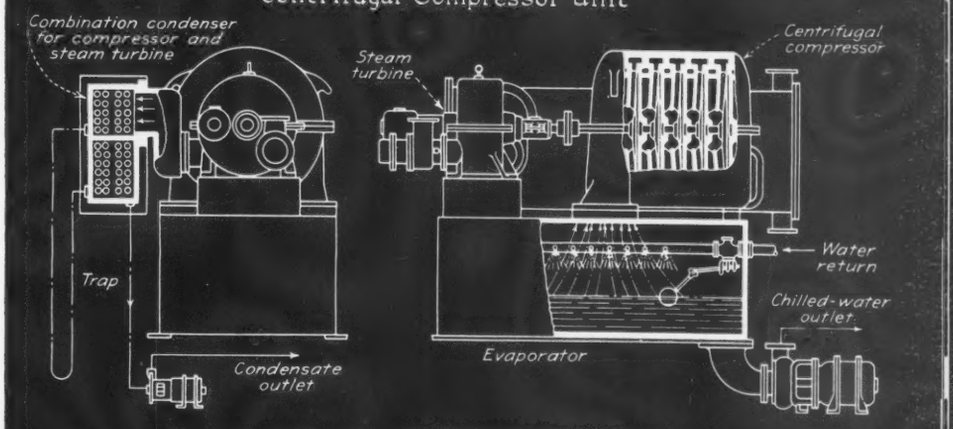
Electric motors, internal-combustion engines, and steam turbines are commonly employed as compressor drives. The first two meet speed and operating characteristics of reciprocating compressors, while the latter is particularly suited to high-speed centrifugal units. However, almost any combination is technically possible and actual choice depends on economics.

In ice and cold-storage plants, where major load is refrigeration and there is little need for steam or heat, motors and internal-combustion engines get the call. Steam drive offers flexibility of control and possibilities of real savings where heat-balance conditions are favorable. Such units have proved their economy in department stores, institutions, breweries, and industrial plants.

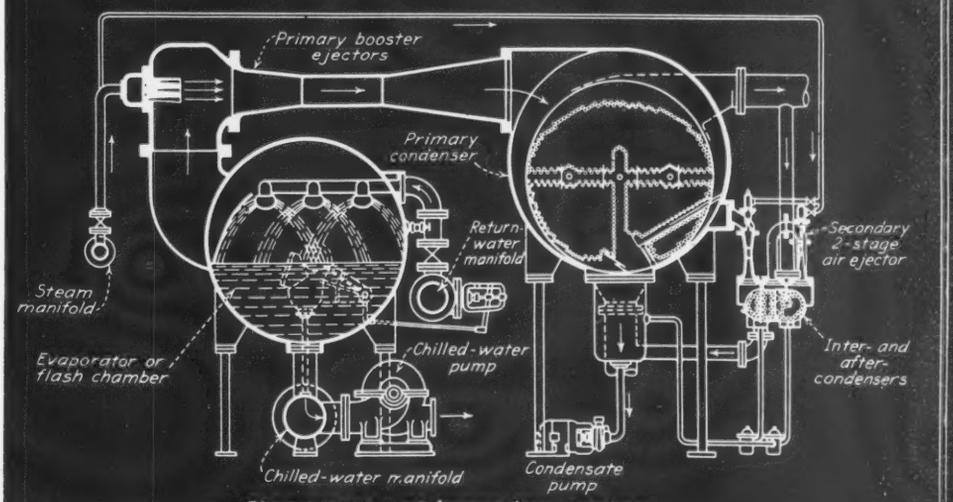
Some manufacturers build units combining internal-combustion power cylinders and compressors cylinders, either in line or at right angles.



Centrifugal Compressor Unit



Turbine-Driven Centrifugal Water Vapor Unit



Steam-Jet Refrigeration System

ABSORPTION SYSTEMS

THE SIMPLE ABSORPTION SYSTEM previously described, consisting of absorber and generator, plus condenser, expansion valve and evaporator, works but it is inefficient and possesses practical operating disadvantages. A complete ammonia absorption system is shown below, and includes additional apparatus such as rectifier, separator, weak-liquor cooler, and exchanger, as well as improvements in design of absorber and generators.

Gas from evaporator flows to absorber, which consists of a bank of shells with welded steel heads, each containing seven small tubes for cooling water. Return bends make a continuous path for water from bottom to top of absorber. Weak liquor flows to top pipe from aqua-ammonia tank, under control of a regulator working on liquid level in tank. Gas enters bottom of each pipe, coming in contact with weak liquor. Strong liquor formed passes to aqua-ammonia tank and then to pump suction.

Other absorber types include: horizontal tubular multi-pass, vertical tubular single-pass, double-pipe, and atmospheric units. These resemble, in general construction, corresponding condenser types described and illustrated on the next page.

The ammonia pump, a simplex reciprocating unit, forces strong liquor to the rectifier, which removes water vapor formed with ammonia vapor in the generator. Strong liquor cools hot gas enough to condense most water vapor, and cooled ammonia vapor passes on to the condenser. The rectifier shown resembles the absorber in general construction, with gas in the large pipes flowing in reverse direction to strong liquor in the small tubes, which flows from bottom to top. Rectifiers also come in the double-pipe and also in the shell-and-tube construction.

Strong liquor picks up further heat before entering the generator, by passing through a heat exchanger in counterflow to weak liquor returning from the generator. Shell-and-tube and double-pipe exchangers are available.

The generator heats strong liquor and drives off ammonia as a vapor. Unit shown consists of a cylindrical shell carrying a bank of tubes closed at one end and expanded into the shell head at the other. Smaller distributing pipes carry low-pressure steam from a steam chest to these tubes and condensate returns between distributing tube and larger tube. Strong liquor enters top of shell and weak liquor flows out at bottom. Gas leaves through an outlet at the top. An alternative construction features steam admission to shell space, with liquor flowing through the tubes in a multi-pass arrangement. Gas generated in tubes is released in a separator drum.

Weak liquor leaving generator flows first to exchanger described above, where it is cooled by strong liquor, and then to a multi-tube or double-pipe weak-liquor cooler where water removes additional heat.

Condenser and evaporator perform same function as in compression system and may be selected from types available (see following pages).

Steam pressure depends on pressure needed in generator and that, in turn, depends on condensing pressure and water temperature. For usual range of water temperature, pressure runs 5–20 lb gage. High water temperature means high steam pressure.

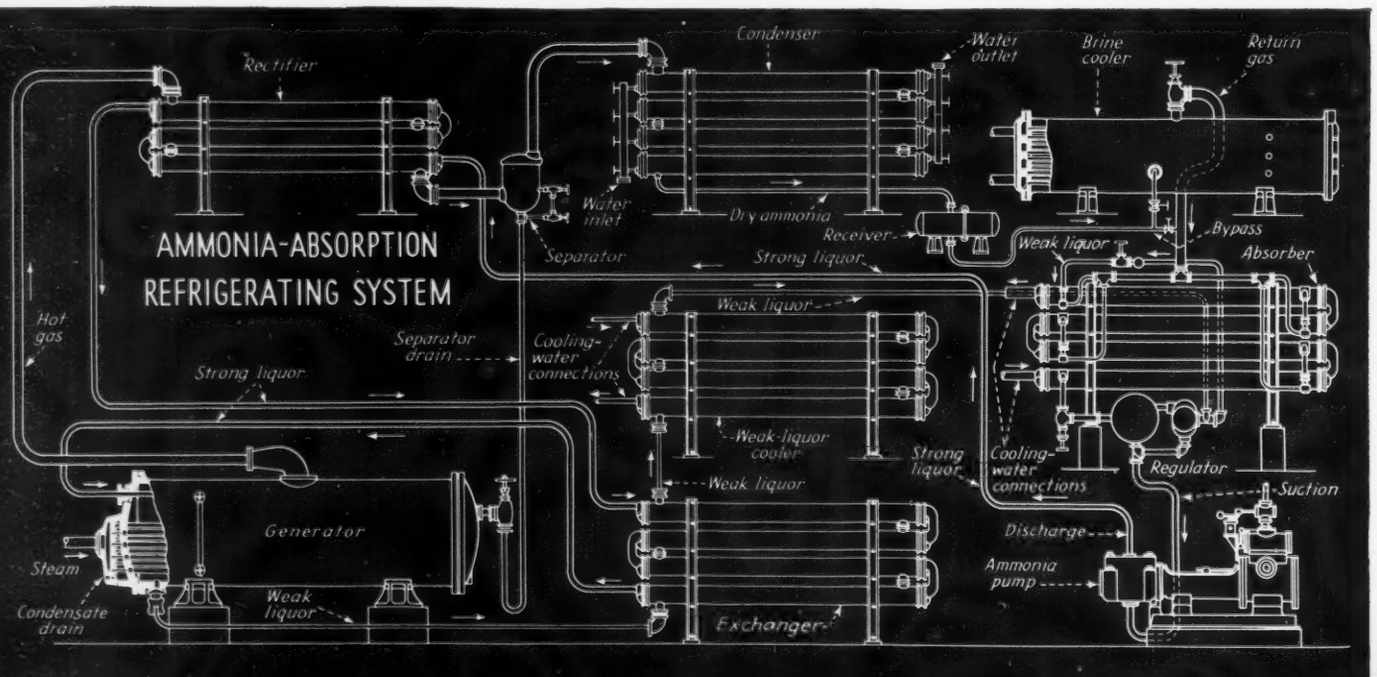
Absorption systems take more cooling water because they depend on heat compression. Where water is plentiful, usual plan involves piping it in series through condenser, absorber, and weak-liquor cooler. Where water is scarce or temperature high, parallel flow is best.

Absorption units find most use where steam and water are cheap. Since they work with liquids in nearly all parts of the cycle, absorption systems are well adapted to low-temperature work, where large volumes of vapor reduce compression-system capacity. For most work, complication, space requirements, and cost put the absorption system at a disadvantage when compared to high-speed compression systems.

New Absorption Units

Recently efforts have been made to bridge the gap between large ammonia absorption plants and the small ammonia-hydrogen systems used in gas-fired domestic refrigerators. Now moderate capacity units (8 to 20 tons) using methylene chloride (dichloromethane) as refrigerant and dimethyl ether of tetraethylene glycol as absorbent, are available. These are standardized units, complete with steam-heated generator, water-cooled condenser and absorber, heat interchanger, solution pump, and evaporator for water cooling.

There has been no extensive use in the refrigerating field, of absorption systems employing solid absorbents, although such devices find a few applications for dehumidification in air conditioning and in industrial processes.



CONDENSERS

FIVE MORE OR LESS distinct types of condensers are in use: (1) submerged, (2) atmospheric, (3) double-pipe, (4) shell-and-tube, (5) evaporative.

Submerged condensers, consisting of a pipe coil in a tank of water, are little used today. Refrigerant flows downward through coil; water enters tank at bottom and rises as heated, leaving through overflow connections. Poor circulation makes submerged condensers inefficient and bulky. Coil design hampers cleaning, but construction is simple and repairs are easily made.

Atmospheric condensers are also simple, consisting mainly of pipe and fittings. Refrigerant flows downward through a series of horizontal pipes, one above the other, connected by return bends. Above each vertical stack of pipes, a water header feeds a perforated trough which allows water to trickle down over exterior of pipes. To get efficient counterflow cooling, refrigerant would have to enter at bottom, which would mean that condensed refrigerant would trickle back against the incoming hot gas and some would revaporize. The bleeder atmospheric condenser overcomes this by a series of pipes to take condensed refrigerant back to receiver directly.

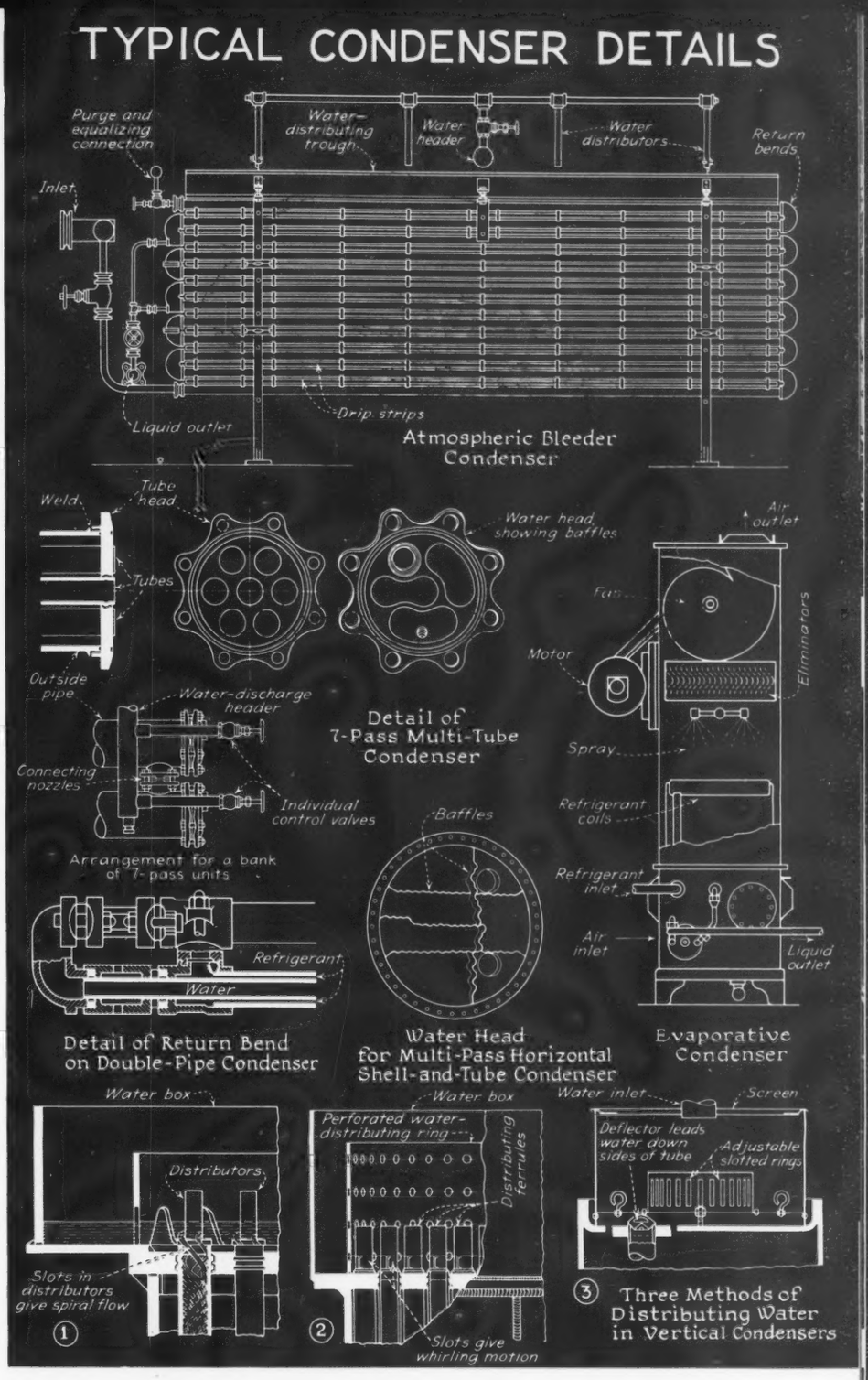
"Flooded" Condensers

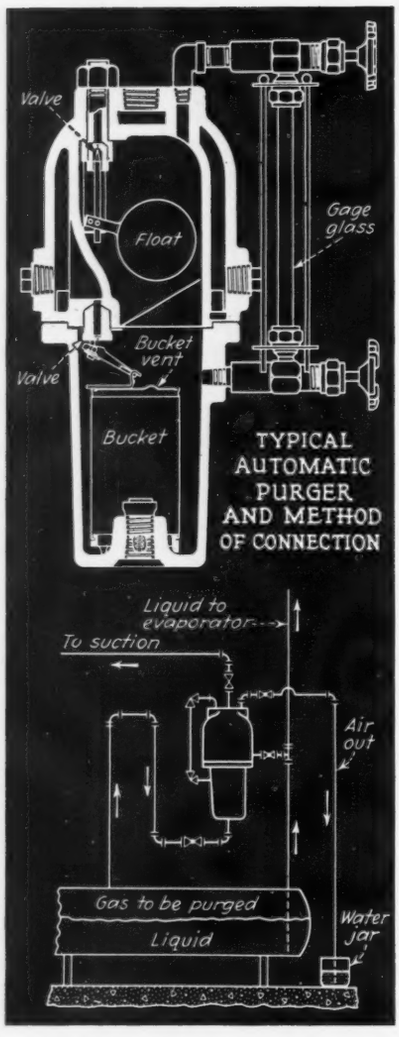
A third variation on atmospheric condenser construction works on the theory that heat transfer to liquid refrigerant is better than to gas, everything else being the same. These "flooded" atmospheric condensers use an ejector to mix incoming hot gas with liquid from bottom coils, mixture being carried to top coils for downward flow. There is some question whether gain from flooded operation outweighs complications introduced.

Atmospheric condensers fit jobs where bad condenser water must be used, since scale formed on outside of tubes can be removed easily. To lift water to trough takes little pump power; gravity does the rest. Some evaporative cooling takes place so atmospheric condensers are economical of water (discussion of evaporative condensers shows how evaporation saves water). Simple construction and ease of repair of these condensers appeal to operators.

Double-pipe and shell-and-tube condensers eliminate exposed water flow, which may be a nuisance in some places. Double-pipe units have water flow in inner pipe and refrigerant in outer. Sketch shows typical end construction. Pipes are arranged horizontally, much as in atmospheric condensers, and banks of pipe may be arranged side by side in large installations. Vapor flows downward and water upward giving efficient counterflow cooling. Double-pipe condensers can be put almost anywhere except in hot corners or exposed to sun. Capacity can be increased by providing for water flow over outside of pipes, as in atmospheric units.

Shell-and-tube condensers derive from steam practice. Vertical units save floor space. Usual construction features open water box at top which permits tubes to be cleaned while condenser is in operation. Both water and refrigerant flow downward. Sketch shows devices to insure good water distribution among tubes and to give water a swirling motion to wet thoroughly inner tube surface. Condensed refrigerant flows down outside tubes, keeping surfaces wet and improving heat transfer. Usual design gives large liquid-storage space in bottom of unit. Vertical condensers are low in installation cost, adaptable to simple purging connections, and can be





overloaded slightly by increasing water flow.

Horizontal shell-and-tube condensers are usually multi-pass units; baffles on waterbox heads direct water flow back and forth through groups of tubes. In small diameter shells, each tube may constitute a pass; unit shown in illustration has seven passes and seven tubes inside an 8-in. shell. Common practice is to divide total load between several condensers, arranging them in vertical banks. Water connections are parallel; gas may enter top shell and pass through in series or each shell may have its own gas and liquid connections.

Cost of water usually dictates some kind of recirculating system with means for cooling water before returning it to condenser. Cooling is usually accomplished by evaporation in a pond or tower. Principle is simple: if water is exposed to air containing less moisture than it could hold (not saturated), some water evaporates, latent heat required coming from remaining water, which is cooled. Spray ponds and cooling towers are merely devices for bringing as much water in intimate contact with air as possible.

The evaporative condenser, as its name implies, utilizes evaporative action to condense refrigerant. Refrigerant flows through coils, usually with finned surface to increase heat transfer, and water drips over coil surface. Fans blow air over coils, causing evaporation of water on coil surface. Latent heat required comes from refrigerant, which condenses. By using latent heat of water rather than mere temperature rise, as in an ordinary condenser, the evaporative condenser gets by on about 1/10 as much water. In all but small units, water not evaporated drips down to a sump and is recirculated by a small pump. Evaporative condensers can be bought in sizes up to about 75 tons and can be combined in banks for larger installations.

How Much Water?

Temperature and quantity of cooling water and condenser effectiveness determine head pressure and so affect power consumption. Designer seeks best possible balance between condenser size and cost, water requirements, and power consumption. With a given condenser and system, lowest possible head pressure depends on temperature of cooling water, but how closely this can be approached depends on amount of water circulated. Operator must balance cost of water and pumping against cost of compressor power to determine best operating point (see POWER, page 384, July, 1938, for instructions).

Purging

By leakage and by decomposition of oil and refrigerant, various inert gases get into systems. These cannot be condensed. Their presence raises condenser pressure and so increases compressor work. They also tend to cover surfaces with a film which retards heat transfer. Removing such gases is called purging and is a vital factor in efficient refrigerating-plant operation.

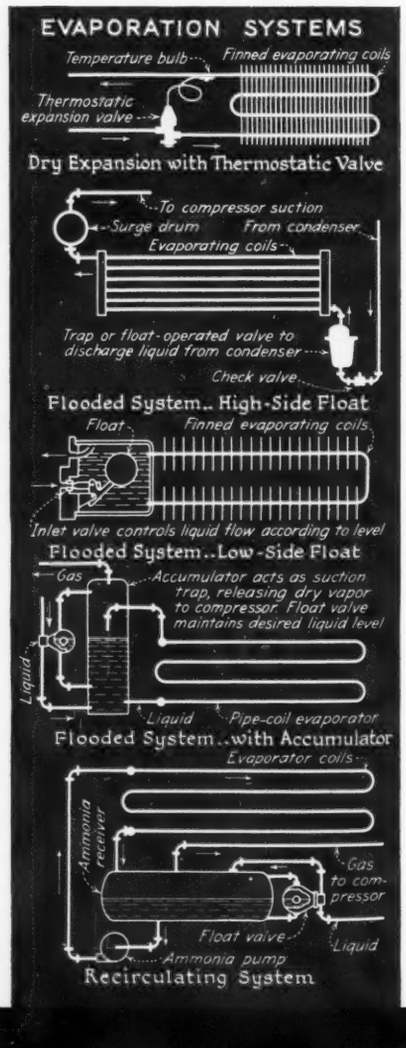
Lighter gases collect in top of condenser, but most go to bottom and eventually show up in receiver. Condensers are commonly fitted with connections at the top for removing non-condensible gases. Automatic devices for purging non-condensible gases from the receiver separate refrigerant vapor from inert gas by condensing vapor and allowing non-condensibles to escape. A typical unit is shown, with the method of connection. In normal operation, body is partially full of liquid refrigerant and mixture of refrigerant vapor and inert gas enters at bottom under inverted bucket, bubbling upward through vent. Jacketed space is at suction pressure which keeps top frosted and chills liquid in body. Refrigerant vapor passes through chilled liquid, comes in contact with cold walls, and is condensed. Inert gas collects and forces liquid level down until float-actuated needle valve opens.

Cooling Liquid and Gas

Vapor leaving the compressor is usually superheated, so some heat must be removed before it can be condensed. This is usually done in the condenser but sometimes it may be done separately, with water that has been previously used and so is at high temperature. Gain from precooling comes from use of valueless high-temperature water to remove high-level heat.

In a normal condenser, with most of inert gases purged, it is impossible to cool liquid below saturation temperature corresponding to pressure in condenser. But cooling below this point increases refrigerating effect without adding to compressor work, so if cold water is available it may be economical to subcool liquid.

Further economies often result from intercooling when plant operates at two suction pressures. Vapor at higher suction pressure may be used to cool liquid (see Applications, page 88) and superheat may be taken from gas between stages by bringing in contact with liquid so that a portion of the liquid flashes to vapor, absorbing heat in the process. (See POWER, page 320, June, 1939.)



EVAPORATION, CONTROL

REFRIGERATION GOES TO WORK when liquid refrigerant draws heat from its surroundings by vaporizing. The general term "evaporator" covers equipment in which this boiling process takes place; types of evaporators are described in the following section on applications, page 88. This section concerns the evaporation process itself and its control.

The first control job is at the evaporator—to regulate liquid flow so that the evaporation rate will meet load requirements. However, when the load is light, only a little refrigerant is vaporized and the compressor pulls suction pressure down. When the load increases, more refrigerant evaporates and suction pressure rises. A constant-speed compressor in this way adapts itself to load changes but such self-regulation wastes power. Some control in addition to regulation of liquid flow is needed to match compressor pumping rate to load.

Evaporation Control

Considering control of evaporation rate, there are three basic methods of operation; type of control depends on which is employed. The methods are: (1) dry, (2) flooded, and (3) recirculating. In the first, liquid flow into the evaporator is regulated so that nothing but vapor leaves at the outlet. There is no definite liquid level in a dry-expansion evaporator; level tends to vary with load.

Where loads are steady, refrigerant flow to a dry expansion coil could be regulated by a manually controlled valve, or even by a fixed orifice. Simplest and oldest automatic control is the constant-pressure expansion valve (pressure-reducing valve) which maintains constant pressure in the evaporator regardless of load. This means that both evaporator and compressor tend to run at constant capacity. To meet load changes, it is customary to start and stop the compressor by a switch actuated by temperature in the space to be cooled. With this scheme, compressor and evaporator work at full load when in operation.

Most common control for dry expansion is the thermal expansion valve. This is usually a diaphragm or bellows valve with suction pressure and spring loading balanced against vapor pressure from a sealed bulb charged with liquid refrigerant. The bulb is usually strapped to the suction line at the evaporator outlet so that temperature of liquid refrigerant in the bulb and vapor temperature are the same.

To insure complete evaporation in the coils, vapor leaving must be slightly superheated and this valve operates to maintain constant superheat. Changes in load cause the valve to open or close, admitting more or less liquid as needed to keep superheat constant. This means that suction pressure varies with load, dropping when load falls off and increasing when load picks up.

Compressor control with thermal expansion valves to regulate liquid flow can be secured in a number of ways. With a liquid receiver, the compressor can be started and stopped by a float switch working from liquid level in the receiver. The compressor can also be started and stopped by a suction-pressure switch, cutting out on low pressure and cutting in when it rises.

Thermostatic control can be applied, but it usually controls compressor operation indirectly. A solenoid stop valve in the liquid line is most often controlled by temperature in the space to be cooled. When this stop valve closes, lack of refrigerant in the evaporator means that suction pressure will drop and a pressure switch cuts off the compressor. When the stop valve opens, flow of refrigerant starts the compressor. An advantage of the solenoid liquid valve is positive closing.

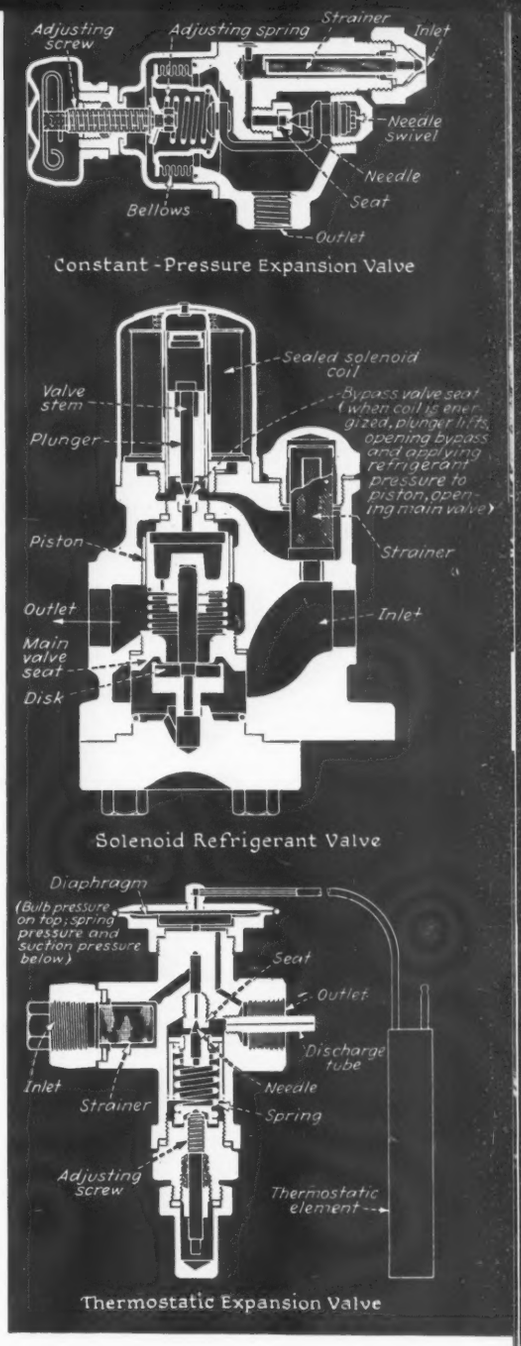
Flooded Systems

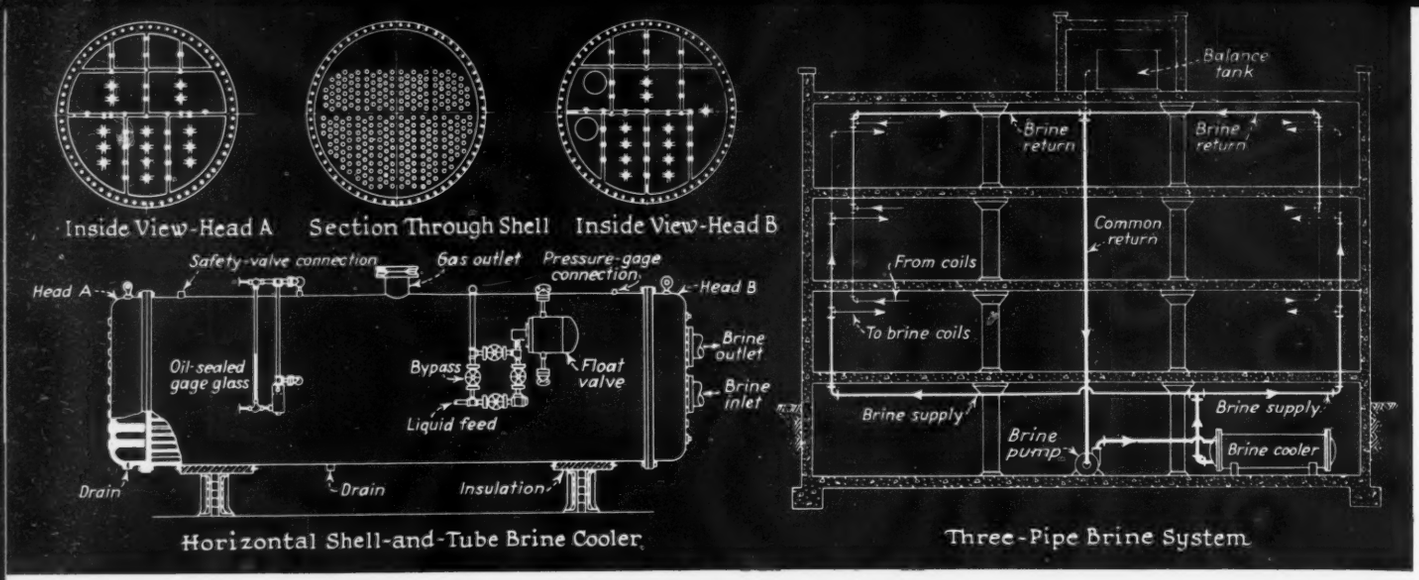
Flooded evaporators get their name by being always nearly full of refrigerant. This means better heat transfer due to wetted surface but requires a larger refrigerant charge. Flow of refrigerant is controlled by float valves, classified by location of the float. In the high-pressure float arrangement, the float valve (or trap) drains liquid from the condenser directly to the evaporator. There is no liquid receiver. The float valve prevents passage of vapor. This draining operation tends to keep the evaporator nearly full, liquid level depending on amount of charge in system. Control of compressor operation by a thermostat in space to be cooled is common.

The usual flooded evaporator in large installations includes a low-side float; that is, a float actuated by liquid level in the evaporator. The float may actuate a liquid-control valve or an electric switch in the circuit of a solenoid valve. Compressor control is usually by suction pressure, which varies with refrigerating load. If compressor is operated intermittently, the suction-pressure switch will start and stop it when pressure limits are reached. With larger units, intermittent operation is not desirable and the suction-pressure switch actuates one of the various devices for capacity control such as a suction bypass or a capacity-reduction pocket.

The third system uses a pump to recirculate ammonia and thus further improve heat-transfer rate. Flow is downward through coils to a receiver from which vapor flows to the compressor suction. Liquid flow to receiver is under control of a float valve working from receiver level.

The above examples illustrate a few common arrangements for evaporator and compressor control. Combinations grow in complexity when the number of compressors or number of evaporators increases.





BRINE SYSTEMS

DIRECT EXPANSION of refrigerant in suitable pipes or coils, located in the space to be cooled, forms simplest set-up. Indirect systems, however, offer advantages for certain applications and are widely used. In the latter, the expanding refrigerant chills a separate cooling medium which is then circulated to the spaces to be cooled. For high-temperature work, (air conditioning and some industrial applications) water may be used. Cooling mediums with lower freezing points are called brines.

Usual commercial brines consist of chlorides of sodium, calcium, and magnesium, in water solution. Trend to lower brine temperatures (to reduce size of piping and equipment) has thrown preference to calcium chloride, which has a low freezing point. Other requirements of a good brine are: high specific heat to keep down quantity to be circulated, minimum corrosive effect, and freedom from tendency to precipitate or change characteristics.

Solution Strength

Strength of brine solution required depends on temperature to be maintained; brine solution should have freezing point 10–15 F below lowest temperature expected. In practice, strength of solution decreases and periodic checks with specific-gravity hydrometer show amount of chloride to be added to maintain desired strength.

Corrosion presents problems in most refrigerating plants, particularly those with brine systems, and a careful study has been made by a committee of the American Society of Refrigerating Engineers. Its report recommends addition of 100 lb of commercial dichromate of soda for every 1000 cu ft of brine in the system. It takes about one-quarter as much caustic soda to neutralize the acid dichromate. This treatment prevents a large part of the corrosion that would otherwise occur.

Maintaining brine in a neutral condition, neither strongly acid or alkaline, also aids in reducing corrosion. Fresh brines tend to be alkaline and ammonia leakage increases alkalinity. Exposure to air causes absorption of CO_2 making the brine acidic. Alkaline brines attack ice cans and other galvanized surfaces; acidic brines attack ferrous materials. Several color tests are available for giving rough indication needed to keep close to neutral point.

Acidity can be cured by addition of caustic soda or slaked lime; alkalinity by air blowing, by bubbling CO_2 or by addition of sodium bicarbonate. Unless definite tests indicate how much treatment is required, best bet is to treat in small doses until brine tests slightly alkaline with litmus or phenol.

To further reduce corrosion, keep air out of brine: maintain brine at proper level so air won't be sucked in around agitators, keep glands and stuffing boxes on brine pumps tight, see that return brine lines discharge under the surface, and keep brine up to strength (weak brines take up air faster than strong ones). Design of brine system should avoid use of dissimilar metals which fosters electrolytic corrosion.

Heat exchange between refrigerant and brine takes place in a brine cooler. For general brine systems, where brine is to be pumped to various locations, shell-and-tube coolers, either horizontal or vertical, are commonly used. Other general-purpose brine coolers include atmospheric, submerged, and double-pipe types. Construction more or less resembles that for corresponding condenser units. Brine coolers are commonly operated flooded, and accumulators or suction traps may be installed to prevent carryover of liquid refrigerant with suction gas. The sketch shows a typical horizontal multi-pass shell-and-tube brine cooler with float control to maintain desired refrigerant level (about ¾ full).

Brine piping differs little mechanically from water piping, but different flow characteristics of brine must be considered in layout. For small installations, an ordinary 2-pipe system is adequate, but for large plants, the 3-pipe system (shown above schematically) offers many advantages, including adequate venting through balance tank, and equalized pressure drop in each circuit.

Brine-Storage Tanks

Where compressor operating hours must be limited for economic or other reasons, cold may be stored in "hold-over" or "congealing" tanks. In the former, a portion of the part-time refrigeration output goes to chilling stored brine which can be used for cooling when compressor is shut down. In congealing tanks, a weak brine replaces strong, and chilling is carried to the freezing point. Melting of brine-ice takes up heat during off period.

In certain applications, brine sprays may be used for cooling; usually a fan moves air through the spray and out into the space to be cooled. This system gives higher heat transfer, there is less temperature difference between brine and room, less space is required, and there are no pipes to defrost. Disadvantages include poor humidity control and dilution of brine.

PIPING, INSULATION

WATER, OIL, BRINES, and refrigerants are the fluids to be piped in the average refrigerating plant. Of these, only refrigerant piping departs from practice common in other fields.

Refrigerant piping design aims at reducing leakage, avoiding corrosion, and keeping pressure drop to an economic minimum. Iron or steel usually fills the bill for ammonia and CO_2 systems, and also for larger plants using other refrigerants. Copper and brass piping and tubing find wide use in smaller units employing low-pressure refrigerants. Aside from avoiding two or three metal and refrigerant combinations (see refrigerant table), choice depends on size of line and pressure.

Extensive use of welding cuts down leakage in ammonia and CO_2 systems. Numerous special fittings are made for ammonia service; a proposed standard brings dimensions for them into line. Use of tongue-and-groove flanged joints on many ammonia fittings and valves makes for tightness. With copper and brass pipe and tubing, flared tube fittings and sweated fittings of various designs are commonly used. In Freon systems, sweated fittings replace threaded to avoid leakage.

Refrigerant Valves

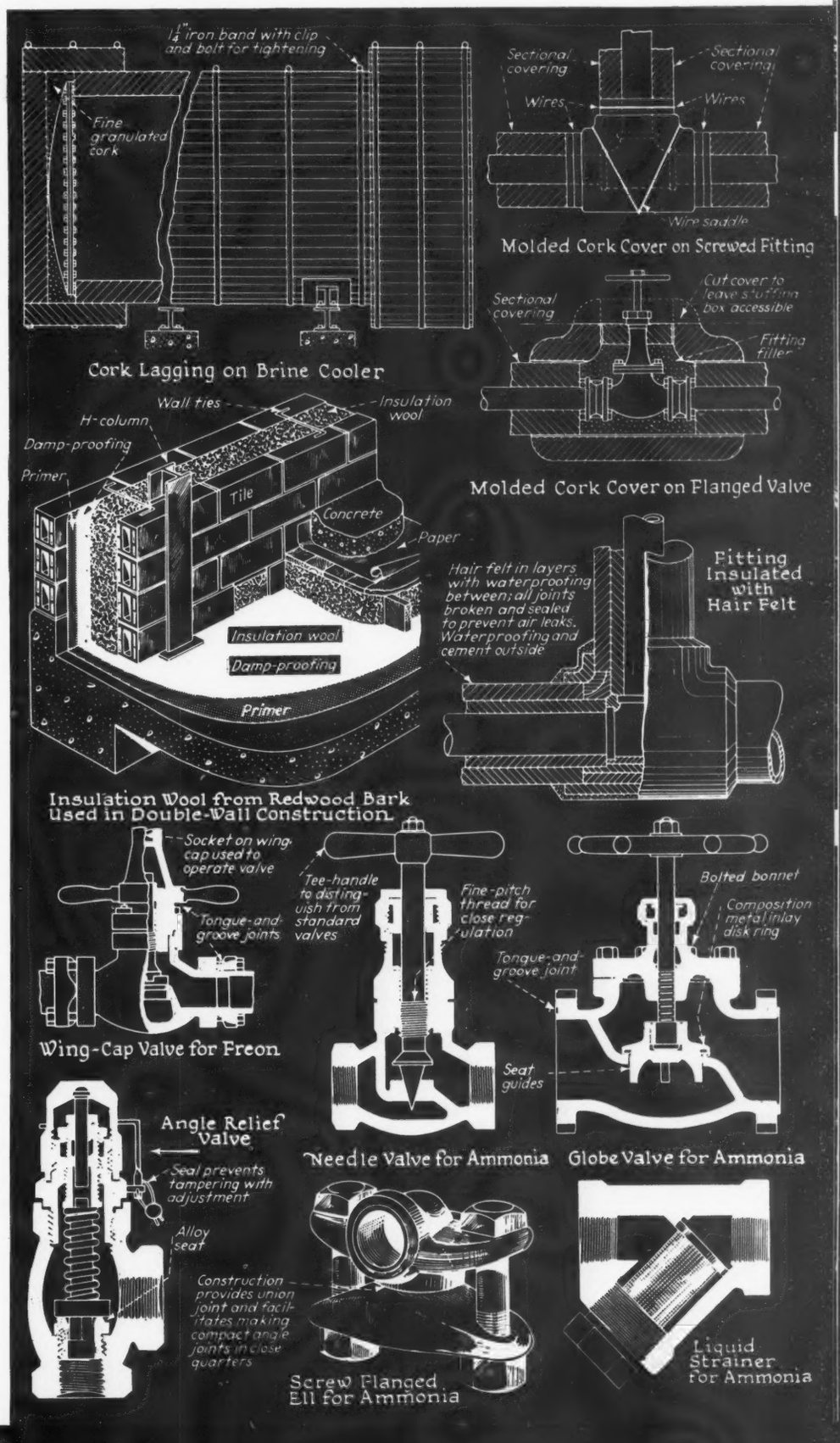
Typical valves for refrigerant service are shown, including a wing-cap valve. Body and trim materials must not be subject to refrigerant attack; in the case of ammonia this means all-ferrous construction, often with composition-metal inlay disks. Strainers prevent foreign matter reaching expansion or control valves, and scale traps and strainers do the same job on the suction side of the compressor.

Insulation in refrigerating plants differs from power-plant insulation in temperature range and importance of moisture. Moisture condenses in the voids of materials used, accumulating on the colder inside surfaces. This lowers insulating value, and may cause rotting or disintegration of material. Trouble can be reduced by use of materials with little tendency to absorb moisture, and by careful design and adequate waterproofing.

The ideal insulating material would, in addition to resisting moisture, show low heat conductivity, be free from rotting or molding, would not harbor vermin, be at least fire-retardant, and be cheap and easy to install.

Corkboard, made from cork granules compressed with a binder, finds wide use as a wall and roof insulator (in sheets or panels), as a pipe covering (in sectional form), as an equipment insulator (in strips or lags), and as a valve and fitting insulator (molded). Hair felt, applied in layers with waterproofing membranes between, finds application on pipe, fittings and equipment. Insulation wool, made from redwood bark, is used as a filler in double-wall constructions, and can be made up, with sheathing, into panels for wall and ceiling application. Balsa-wood panels and aluminum foil also offer advantages for refrigeration insulation.

Other materials include boards made of mineral wool, treated hog hair and asphalt, sugar-cane fibre, wood fibre, and blankets of cellulose tissue, wood pulp, kapok, fine-fibre rock wool, and glass wool. Loose-fill materials include rock and glass wool.


1/4" iron band with clip and bolt for tightening
Fine granulated cork
Cork Lagging on Brine Cooler
Sectional covering
Wires
Wire saddle
Molded Cork Cover on Screwed Fitting
Cut cover to leave stuffing box accessible
Fitting filler
Molded Cork Cover on Flanged Valve
Wall ties
H-column
Damp-proofing
Primer
Tile
Concrete
Paper
Insulation wool
Damp-proofing
Primer
Insulation Wool from Redwood Bark Used in Double-Wall Construction
Hair felt in layers with waterproofing between; all joints broken and sealed to prevent air leaks. Waterproofing and cement outside
Fitting Insulated with Hair Felt
Socket on wing cap used to operate valve
Tongue-and-groove joints
Wing-Cap Valve for Freon
Tee-handle to distinguish from standard valves
Fine-pitch thread for close regulation
Needle Valve for Ammonia
Bolted bonnet
Composition metal inlay disk ring
Tongue-and-groove joint
Seat guides
Globe Valve for Ammonia
Angle Relief Valve
Seal prevents tampering with adjustment
Alloy seat
Construction provides union joint and facilitates making compact angle joints in close quarters
Screw Flanged Ell for Ammonia
Liquid Strainer for Ammonia

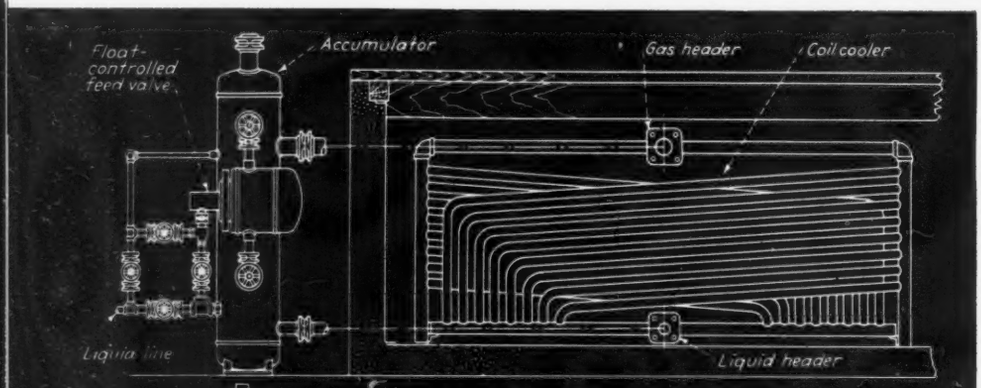
APPLICATIONS

IN THIS COUNTRY, most ice is made in block form, and since experiments proved agitation would produce clear ice from raw water, use of city water or other hygienic supply has replaced distilled water. In most cases brine is the freezing medium; direct-expansion or "dry" ice-making is quite uncommon.

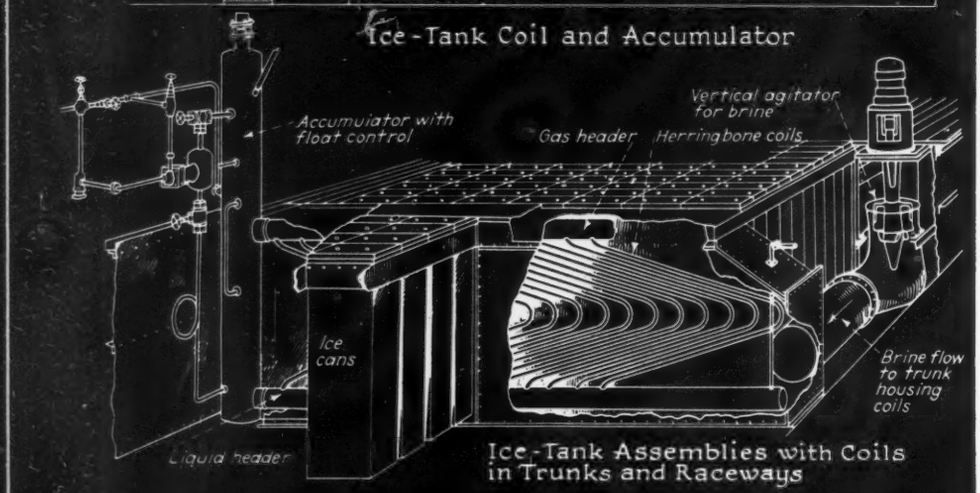
In a typical plant, ice is made in a large tank or "ice field" in which chilled brine circulates between rows of cans containing water. In smaller plants and older ones, a wooden framework supports cans and operators remove or "harvest" them singly or in groups of two or three. In large modern plants, rows of cans are supported by a galvanized grid so that a row or half a row can be lifted at one time by an overhead crane. Tanks are commonly made of steel plate, well insulated on bottom and sides. Wooden covers, placed directly on grids, form insulation for the top as well as providing a working floor.

Formerly, long pipe coils with return bends, placed between rows of cans, chilled the brine. Modern plants improve on this arrangement in several ways. One or two brine coolers, at ends of the tank, save space and eliminate piping between cans. Coolers are designed for full-flooded operation and with minimum pipe lengths for low flow resistance. Motor-driven propeller agitators insure positive brine circulation; this improves heat transfer rate.

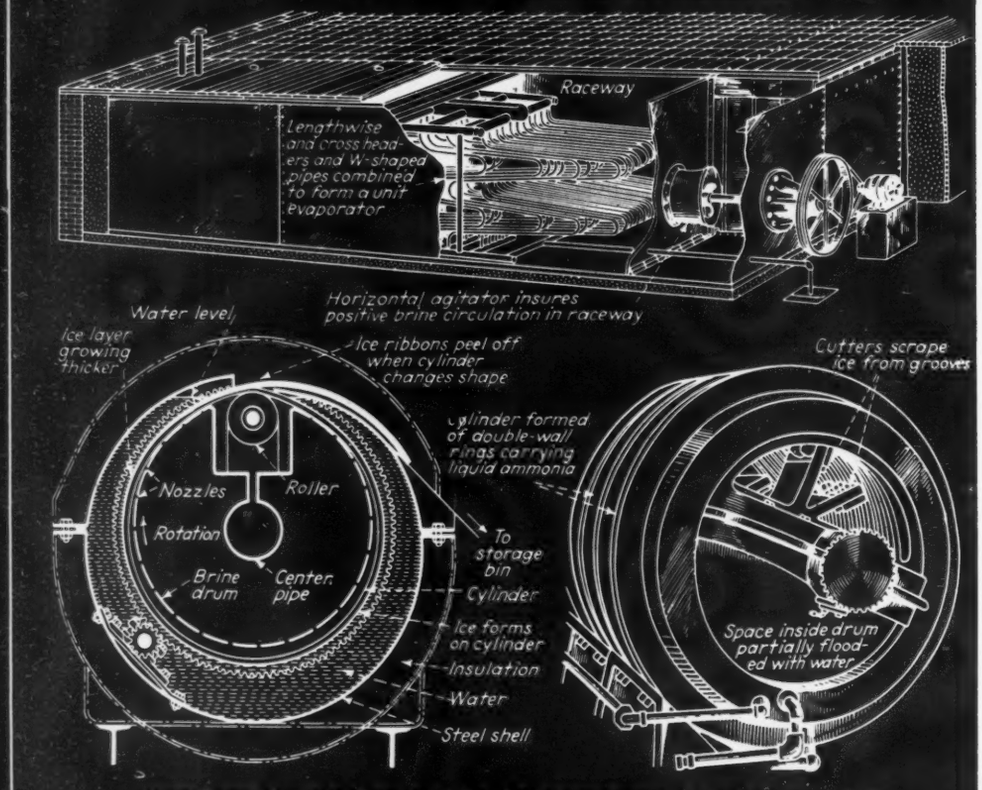
Submerged shell-and-tube coolers are sometimes used, with agitators forcing brine through tubes into the ice tank. Often the cooler consists of high-efficiency coils installed in a trunk or raceway through which brine flows at a rapid rate, propelled by an agitator. Several designs of coils are shown.



Ice-Tank Coil and Accumulator



Ice-Tank Assemblies with Coils in Trunks and Raceways



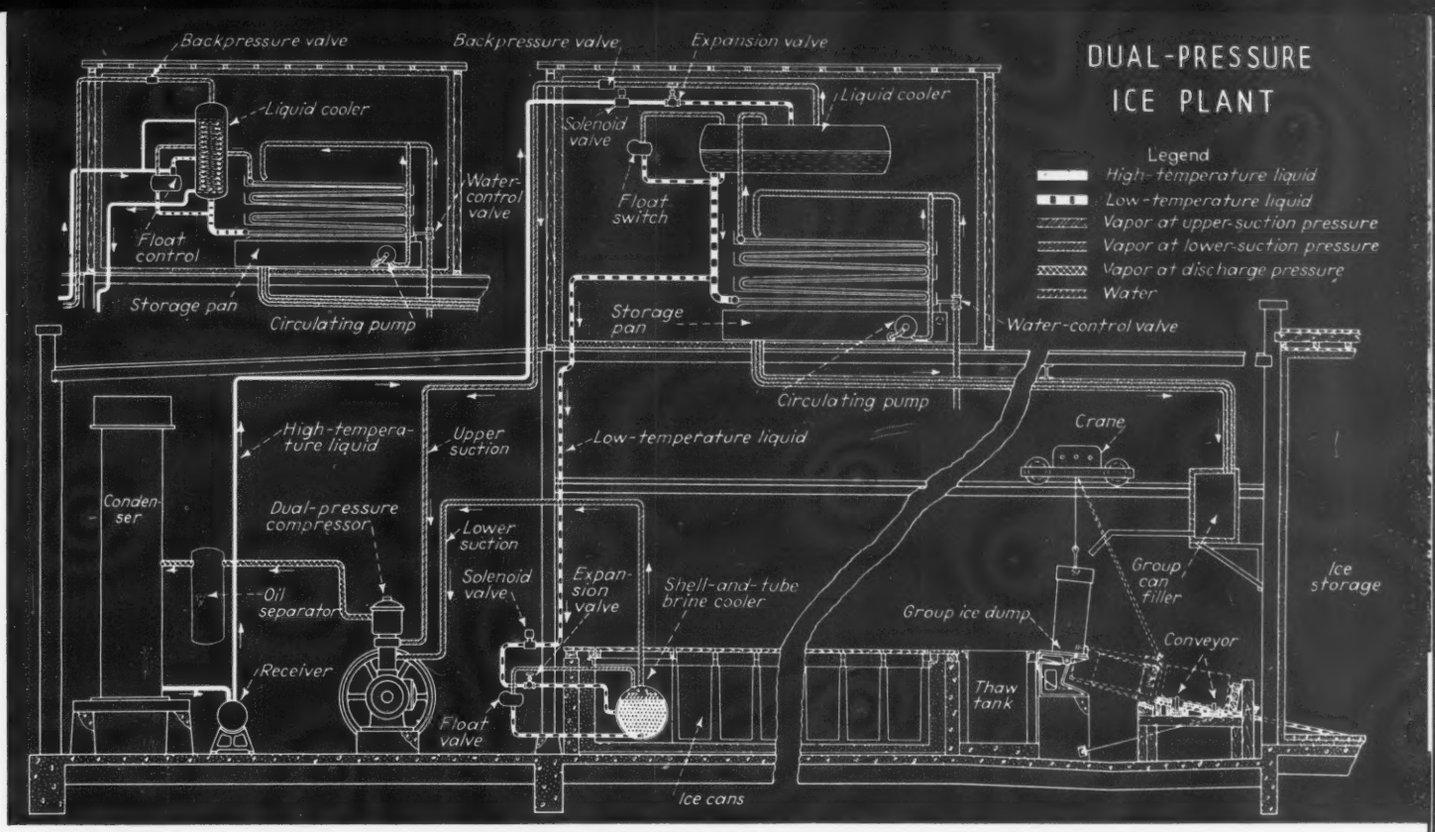
Machines for Making Ice in Ribbons and Crystals....

Brine Temperature

Low-pressure float valves control refrigerant flow in most cases, superseding the formerly much used hand expansion valves. Brine temperature and rate of circulation largely govern speed of freezing. Many plants operate at high freezing rates to get maximum tonnage from equipment. This often gives least over-all cost per ton, in spite of higher power consumption. Limit on lowering brine temperature depends on quality of water used for ice making; with most water, brine can be carried at 12 F without cracking or other ice troubles. With suitable water and controlled ammonia-ion concentration, temperature can be lower.

Use of air to agitate the slow-freezing center part of the cake makes it possible to produce clear ice from raw water. Ice fields are fitted with a network of air piping and an air tube is placed in the center of each can. Air may be at high or low pressure, and tubes may be frozen in the cakes or not. It is common practice to pump out cores when blocks have partly frozen, thus eliminating impurities which tend to collect there. Core spaces are filled with fresh or distilled water.

Before water can be frozen, it must be cooled down to 32 F; this may be done in the cans or in a separate precooler. Use of a precooler segregates this relatively high-temperature work so that it can be carried by a separate system at



higher suction pressure, with considerable power saving. This kind of operation requires two compressors or a dual-pressure machine. Further thermal gains result from using suction gas from a water precooler to cool high-pressure liquid ammonia, and such liquid cooling is customary in dual-pressure ice plants. The diagram shows such a plant, with an alternative hookup for liquid cooling and water precooling. Dual-pressure operation increases plant investment; lower operating costs must be weighed against this increase.

Many ice users need cracked or crushed ice for packing and other purposes where large cakes won't do. Such needs can be met by reducing cake ice to required size, but machines for producing ice chips or crystals directly offer many advantages. Illustrations show the principle on which two such machines work. Each freezes ice in a thin layer on a cylinder. In one case, the ice layer builds up on the outside of a slowly rotating cylinder with direct-expansion coils or brine inside and water outside. At the end of a revolution, near the top, the flexible cylinder changes shape suddenly, but the ice, which is stiff, separates from the cylinder and runs off in a ribbon. Typical units comprise a series of ribbon-producing cylinders on a single axis. As ribbons slide down to the storage bin, they fracture into small chips of convenient size.

In the second machine, ice forms inside the cylinder, which carries refrigerant in grooves between the cylinder wall and casing. A revolving cutter scrapes ice off in crystal form. For many purposes this "snow" needs no further processing. If chips are wanted, the crystals are fed to a briquetting machine which converts them, under pressure, to small lumps.

In addition to making ice directly in the required form, both machines have the advantage of speed, freezing being a matter of minutes rather than hours.

COLD STORAGE

The term "cold storage" covers a lot of ground; it applies to everything from monster metropolitan warehouses to coolers in corner butcher shops. Equipment and operating methods depend mainly on size but also on type of storage and temperatures to be held.

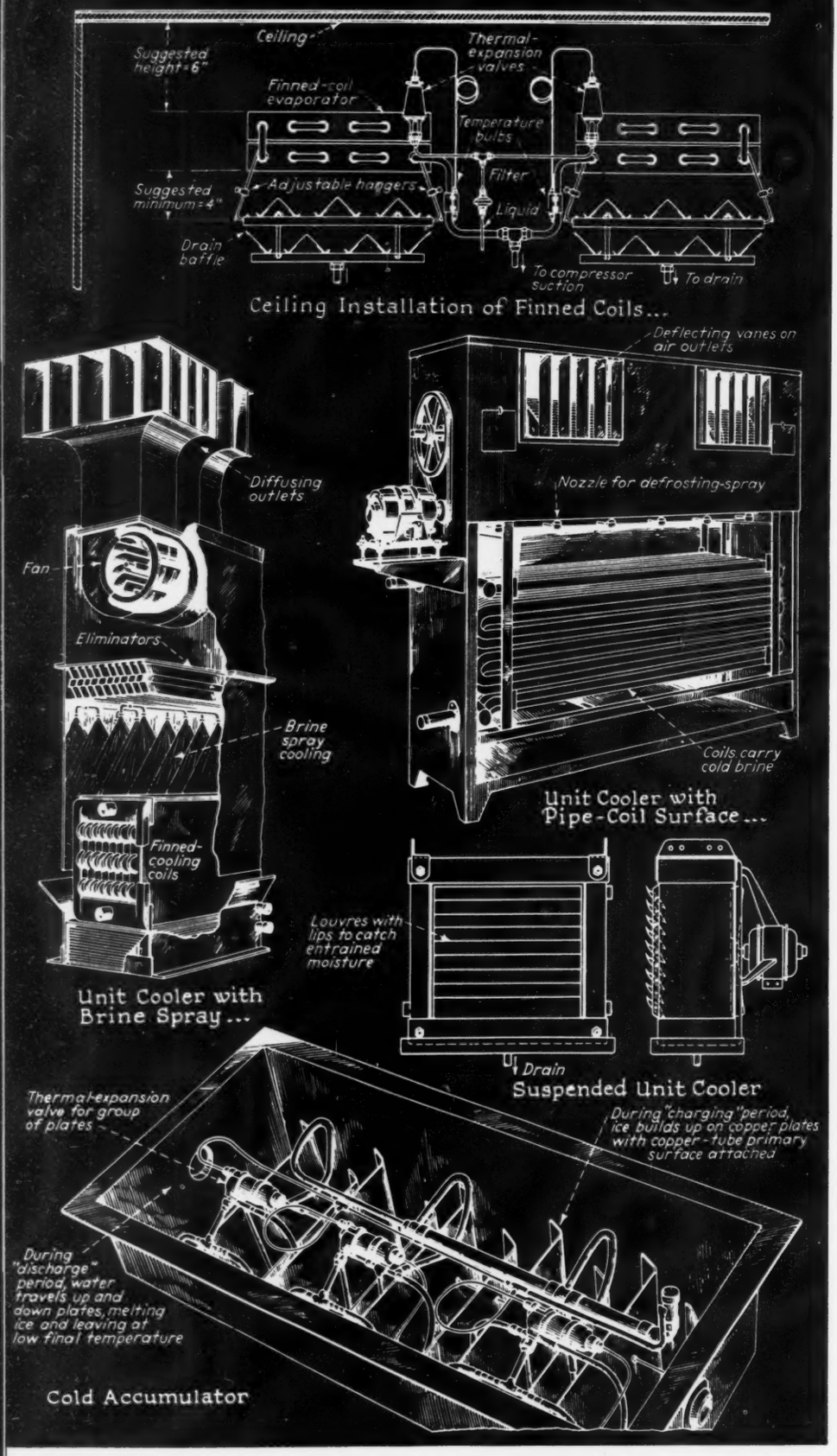
For small installations, trouble-free operation and low investment usually dictate direct-expansion coils controlled by thermostatic expansion valves. This fits well with use of fractional or low-tonnage condensing units using low-pressure refrigerants. Operation of the compressor, usually motor driven, is under control of thermostatic switch and depends on temperature in the cooler; water-regulating valves and high- and low-pressure cutouts make the system fully automatic.

Larger plants also use low-first-cost direct-expansion system, but find ammonia-flooded systems with float control more economical. Where parts of the storage are operated at different temperatures, as in case of freezer rooms, several suction pressures may be used with several compressors or dual-pressure machines.

It is difficult to say at what plant size use of brine circulation instead of direct expansion begins to pay, but above 150,000 cu ft of storage space, brine is commonly used. With only one suction pressure, direct expansion must be used to get lower temperature needed for freezers. An alternative is the 2-temperature-level brine system with booster compressors handling low-pressure suction load. This arrangement fits large installations, say above 1,000,000 cu ft.

So much for the general setup of a system—what about equipment for transferring heat from room to refrigerant or brine? Again size has a lot to do with it, as well as nature of the product cooled and temperature and humidity required. For small and medium size coolers, using direct expansion of low-pressure refrigerant, extended surface or finned coils find wide use because of high transfer efficiency. In larger plants where ammonia is used, plain pipe coils will probably be found and with brine, plain pipe coils are the general rule.

Most cold storages depend on natural convection currents to circulate cold air. Coils are placed to take full advantage of this effect; that is, overhead where possible. Usually some form of drip trough is provided; the drawing on the next page shows one type under finned coils in a ceiling installation. Coils are sometimes partly enclosed, with space for air to flow past. Such an arrangement is called a bunker.



Forced circulation may be used to increase effectiveness of cooling surface. It may be accomplished by placing fans at end of bunkers or by unit coolers similar to those used in air conditioning. Several types are shown; the general principle involves forcing air at high velocity over the cooling surface, thus increasing the heat-transfer rate and making each sq ft of coil surface do more work. Fans also provide positive air circulation in cooler space. Unit coolers may be used for relatively high-temperature work with advantages of compactness and close control. Brine spray overcomes rapid frosting met at low temperatures. Unit coolers may do entire job in small plants or special phases of cooling in large plants.

The discovery that freezing at extremely low temperatures preserves foods in virtually original condition gave a tremendous impetus to development of equipment for "quick" freezing. Temperatures range from —20 F to —50 F. Methods of freezing include direct immersion in low-temperature brine, brine immersion in metal packages, and conveyor and stationary systems in which low-temperature brine is sprayed on metal plates in contact with material to be frozen.

INDUSTRIAL USES

No brief outline of refrigeration can deal in any detail with its numerous industrial uses. These take many forms, but all embody the principles previously discussed—only the combinations vary to meet special needs met in the field.

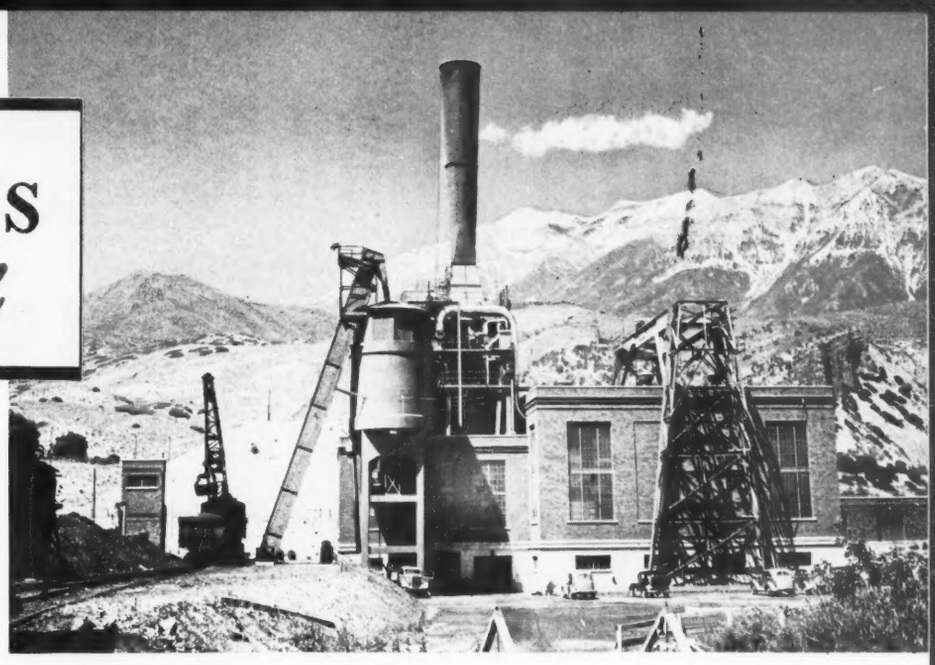
Numerous industrial applications of refrigeration are in processes requiring controlled atmospheric conditions such as lithographing. Equipment and method of operation follows general air-conditioning practice, adapted to meet the special conditions of temperature and humidity encountered.

Another big industrial job for refrigeration is cooling liquids, in breweries, dairies, oil refineries, etc. Ease of cleaning is particularly important for food products. Baudelot coils, in which liquid to be cooled flows over pipes (like water in an atmospheric condenser) are widely used. Other cooler types include double-pipe, submerged, and shell-and-tube.

Specialized cold storage plays a vital part in baking, candy-making, and numerous other industries. These applications may differ from standard storage only in temperatures carried at time of storage, but may include arrangements for chilling goods on slowly moving conveyor lines, and other special setups dictated by process requirements.

In many industries, and of course in air conditioning, peak loads constitute a real problem calling for equipment to store refrigeration economically and efficiently. The accumulator illustrated, comprising a form of evaporator with an extensive copper plate surface on which ice forms ready for quick melting when needed, meets this need. Operating cycle is simple: compressor runs nearly full time, and during the off-peak period, charges this "storage battery" with ice. When the peak comes, ice melts to provide added cooling effect. The accumulator makes possible a smaller compressor and auxiliary equipment and gives improved load factor.

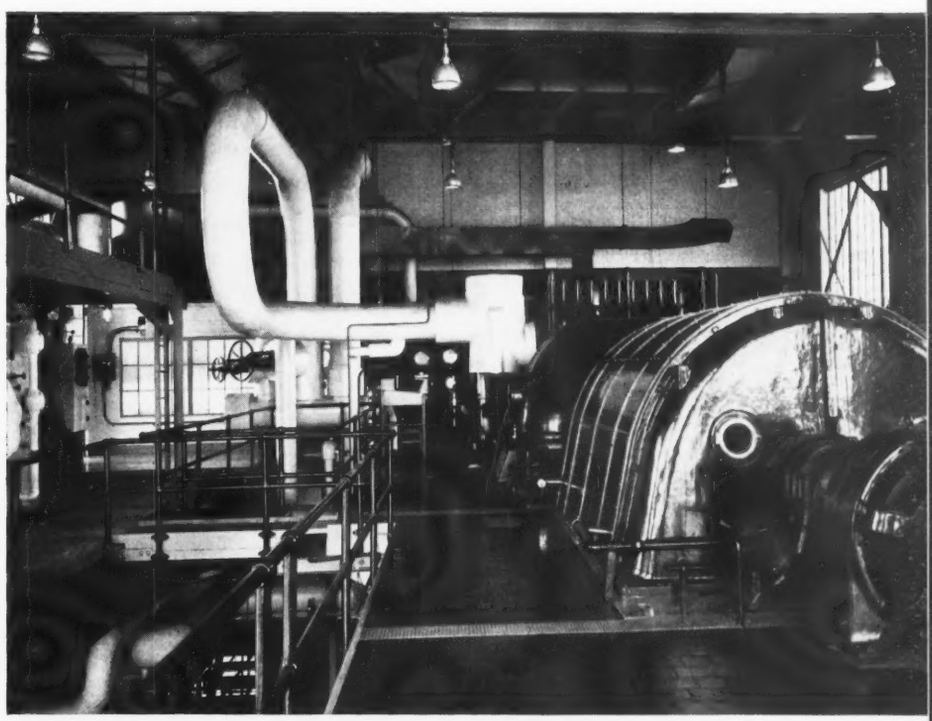
ENGINEER'S *heaven*



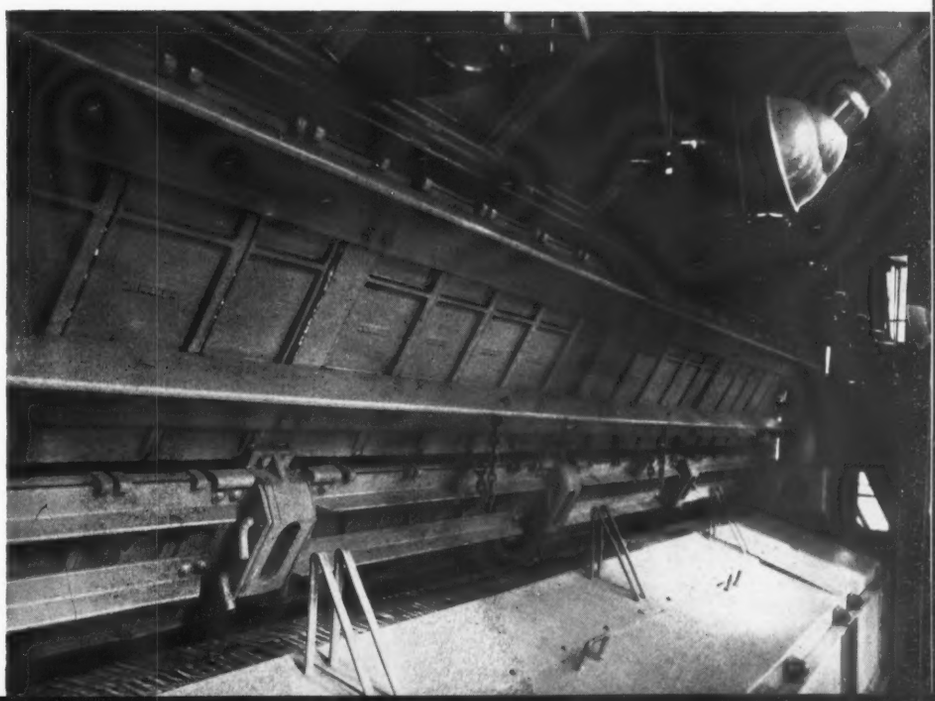
Provo is a "single-unit" plant—one turbine and one outdoor boiler; only feed pumps and ID fans are in duplicate. Now operates at 400 lb and 750 F

Climb west over the Rockies to Salt Lake City. Drive south 35 miles to Provo, Utah, then east five miles to the mouth of Provo Canyon. There, in the shadow of the big mountains, you'll find this engineer's heaven—elevation over 4000 ft—air like blue crystal—sparkling sunshine—the Provo steam-electric plant, Utah Power & Light Co.

Editor Swain, who spotted the plant on his transcontinental jaunt, comments, "This is one of the slickest-looking power set-ups east of the Pacific. Maintained, polished and dusted like the King's yacht, this modern plant (1936), with its outdoor boiler, is manned by a fine crew and set down in a spot of great natural beauty."



The janitor (he must be good) halted his daily floor waxing for photo of the 18,750-kw, 1800-rpm turbine. Place is incredibly clean—they even polish the screw threads on the gate valves in the basement



Mud drum of 200,000-lb-per-hr boiler rests on top of this stoker-operating room. Operator of the chain grate (20 ft square) keeps cozy in here, but men must climb out and up to inspect boiler and blow soot, even at 20 deg below zero. Gage glass is viewed below through a periscope

HIGH primary air temperatures with RILEY PULVERIZERS

THE HOTTER THE BETTER

Partial List of Recent Riley Atrita Pulverizer Installations

POWER OPERATING CO., Cahokia Station
10–20,000 lbs. of coal per hour pulverizers (Repeat Order)
CARNEGIE-ILLINOIS STEEL CO., Ohio Works, Youngstown, Ohio
2–28,500 lbs. of coal per hour pulverizers (Repeat Order)
CITY OF SPRINGFIELD, ILL.
4–9500 lbs. of coal per hour pulverizers (Repeat Order)
HARTFORD ELECTRIC LIGHT CO., CONN.
4–18,000 lbs. of coal per hour pulverizers (Repeat Order)
TENNESSEE ELECTRIC POWER CO.
Chattanooga, Tenn.
2–19,000 lbs. of coal per hour pulverizers
2–9500 lbs. of coal per hour pulverizers
W. VA. PULP & PAPER CO., Williamsburg, Pa.
3–9000 lbs. of coal per hour pulverizers (Repeat Order)
Charleston, S. C.
4–14,250 lbs. of coal per hour pulverizers (Repeat Order)
Luke, Md.
1–28,500 lbs. of coal per hour pulverizer (Repeat Order)
Covington, Va.
3–18,000 lbs. of coal per hour pulverizers (Repeat Order)
LYNN GAS & ELECTRIC CO., Lynn, Mass.
3–14,250 lbs. of coal per hour pulverizers
GENERAL ELECTRIC CO., Bridgeport, Conn.
4–9000 lbs. of coal per hour pulverizers
GENERAL ELECTRIC CO., Pittsfield, Mass.
4–9000 lbs. of coal per hour pulverizers (Repeat Order)
CARBIDE & CARBON CHEMICAL CO., S. Charleston, W. Va.
4–14,250 lbs. of coal per hour pulverizers (Repeat Order)
SHELL PETROLUM CO., Wood River, Ill.
8–9500 lbs. of coal per hour pulverizers
1–19,000 lbs. of coal per hour pulverizer (Repeat Order)
WHEELING STEEL CORP., Portsmouth, Ohio
2–9500 lbs. of coal per hour pulverizers (Repeat Order)
ALLIS CHALMERS MFG. CO., Milwaukee, Wisc.
4–12,000 lbs. of coal per hour pulverizers
WORCESTER SALT CO., Silver Springs, N. Y.
2–14,000 lbs. of coal per hour pulverizers (Repeat Order)
NORTON COMPANY, Worcester, Mass.
2–9000 lbs. of coal per hour pulverizers
WINCHESTER REPEATING ARMS, New Haven, Conn.
2–6750 lbs. of coal per hour pulverizers
WESTERN CARTRIDGE CO., E. Alton, Ill.
3–5250 lbs. of coal per hour pulverizers
GUIDE LAMP CO., General Motors Corp., Anderson, Ind.
1–6000 lbs. of coal per hour pulverizer
CELANESE CORPORATION, Cumberland, Md.
2–14,250 lbs. of coal per hour pulverizers
HEYWOOD WAKEFIELD CO., Gardner, Mass.
2–4500 lbs. of coal per hour pulverizers (Repeat Order)
PORT HURON SULPHITE & PAPER CO.
Port Huron, Mich.
2–9000 lbs. of coal per hour pulverizers
HARTFORD CITY PAPER CO., Hartford City, Ind.
2–9500 lbs. of coal per hour pulverizers
JOHN MORRELL CO., Ottumwa, Iowa
2–9500 lbs. of coal per hour pulverizers (Repeat Order)
UNIVERSITY OF MINNESOTA, Minneapolis, Minn.
2–14,250 lbs. of coal per hour pulverizers
MACANDREWS & FORBES CO., Philadelphia, Pa.
4–9000 lbs. of coal per hour pulverizers
NATIONAL CASH REGISTER CO., Dayton, Ohio
2–9000 lbs. of coal per hour pulverizers (Repeat Order)
LEWISTON BLEACHERY, Lewiston, Me.
1–14,250 lbs. of coal per hour pulverizer
ST. CROIX PAPER CO., Woodland, Me.
2–14,250 lbs. of coal per hour pulverizers (Repeat Order)
CRYSTAL TISSUE PAPER CO., Middletown, Ohio
1–9000 lbs. of coal per hour pulverizer
JOS. E. SEAGRAMS & SONS, Louisville, Ky.
2–9500 lbs. of coal per hour pulverizers (Repeat Order)
KROGER GROCER & BAKING CO., Columbus, Ohio
2–4500 lbs. of coal per hour pulverizers (Repeat Order)
RIVERSIDE METAL CO., Riverside, N. J.
1–9000 lbs. of coal per hour pulverizer
UPPER MICHIGAN POWER & LIGHT CO., Escanaba, Mich.
3–6000 lbs. of coal per hour pulverizers

When using Riley Pulverizers, there is no need to temper primary air as a precaution against explosion in pulverizer or classifier.

There has never been an explosion in a Riley Pulverizer.

The advantages of supplying high temperature primary air to pulverizers, particularly when high moisture coal is used, is generally recognized. When air preheaters are used, efficiency is decreased if pulverizer characteristics demand reduction of primary air temperatures by tempering with room air. One of the main reasons for limiting the temperature of primary air entering a pulverizer is to prevent explosions in or other damage to the pulverizer.

With Riley Pulverizers there is no necessity for reducing primary air temperatures as a precaution against explosion because the velocity of travel of the coal and air mixture is at all times greater than the velocity of flame propagation. Preheated air can be used without tempering. Air temperatures above 600 degrees can and have been used with entirely satisfactory performance.

There has never been an explosion in a Riley Pulverizer in spite of the fact that every available means has been employed to purposely cause an explosion—live coals from a stoker were fed through the pulverizer, spark plugs were installed, actual flames were drawn direct from furnace to pulverizer. Yet no explosion occurred. Absolute proof that with Riley Pulverizers there is no explosion hazard.

High preheated air temperatures can cause no damage to the pulverizer. All bearings are located outside and independent of the pulverizer housing. Mechanically therefore there is no need to limit air temperatures because of possible bearing and lubrication difficulties.

RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore Milwaukee Denver
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS
AIR HEATERS • ECONOMIZERS • STEEL CLAD INSULATED SETTINGS
WATER-COOLED FURNACES • FLUE GAS SCRUBBERS

It will pay you to visit modern Riley Installations

these are obvious reasons for preference for Riley Pulverizers

During the past few years many improvements to Riley Pulverizers have been made and thoroughly field tested. These improvements decrease power consumption and maintenance and increase fineness and capacity. In most cases these improvements can be economically applied to existing installations.

Flexibility—Wide Load Range

Extremely fluctuating loads over a wide range are easily carried because a change in rate of coal feed gives an instantaneous change in coal output, because of ease of adjusting air and coal supply for different loads and because at maximum output only a small percentage of air required for combustion is supplied as primary air, which makes possible continuous operation at extremely low loads. Under favorable conditions, continuous firing has been maintained at such a low rate that no steam was generated by the boiler. Load ranges of 10 to 1 are carried at many Riley installations.

Low Power Consumption

With Riley Pulverizers, coal is first crushed to a granular state and then finely pulverized. This two-stage principle of pulverization partly explains the reason for the low power consumption of Riley Pulverizers. Another reason is the fact that but little power is required to run Riley Pulverizers when running idle. This means very low power consumption at lower loads.

Sustained Fineness of Pulverization

Wear of pulverizing elements of Riley Pulverizers occurs in such a manner as to have but slight effect upon fineness of pulverization throughout their life. A mechanical separating device further assures proper degree of fineness by mechanical rejection of coarse particles.

Low Maintenance

Recent improvements in design have even further reduced the maintenance of Riley Pulverizers. It is also easy and simple to make repairs to Riley Pulverizers. There are no large or heavy parts to replace. A 12,000 pound per hour Riley Pulverizer can be easily completely overhauled within seven or eight hours.

Quiet, Vibrationless Operation

It is generally recognized that the Riley Pulverizer is one of the most quiet pulverizers manufactured. You will undoubtedly be surprised by the quiet vibrationless operation when you first see a Riley Pulverizer in operation.

Ability to Handle Wet Coal

Riley Pulverizers efficiently handle high moisture coals not only because high temperature air can be used, but because nowhere in the pulverizing process is the coal crushed between two surfaces, with the possibility of caking, but throughout is held in suspension, making possible most effective use of drying air. Primary air mixes immediately with the coal. Riley Pulverizers have satisfactorily pulverized coal so wet that water ran out of the feeder.

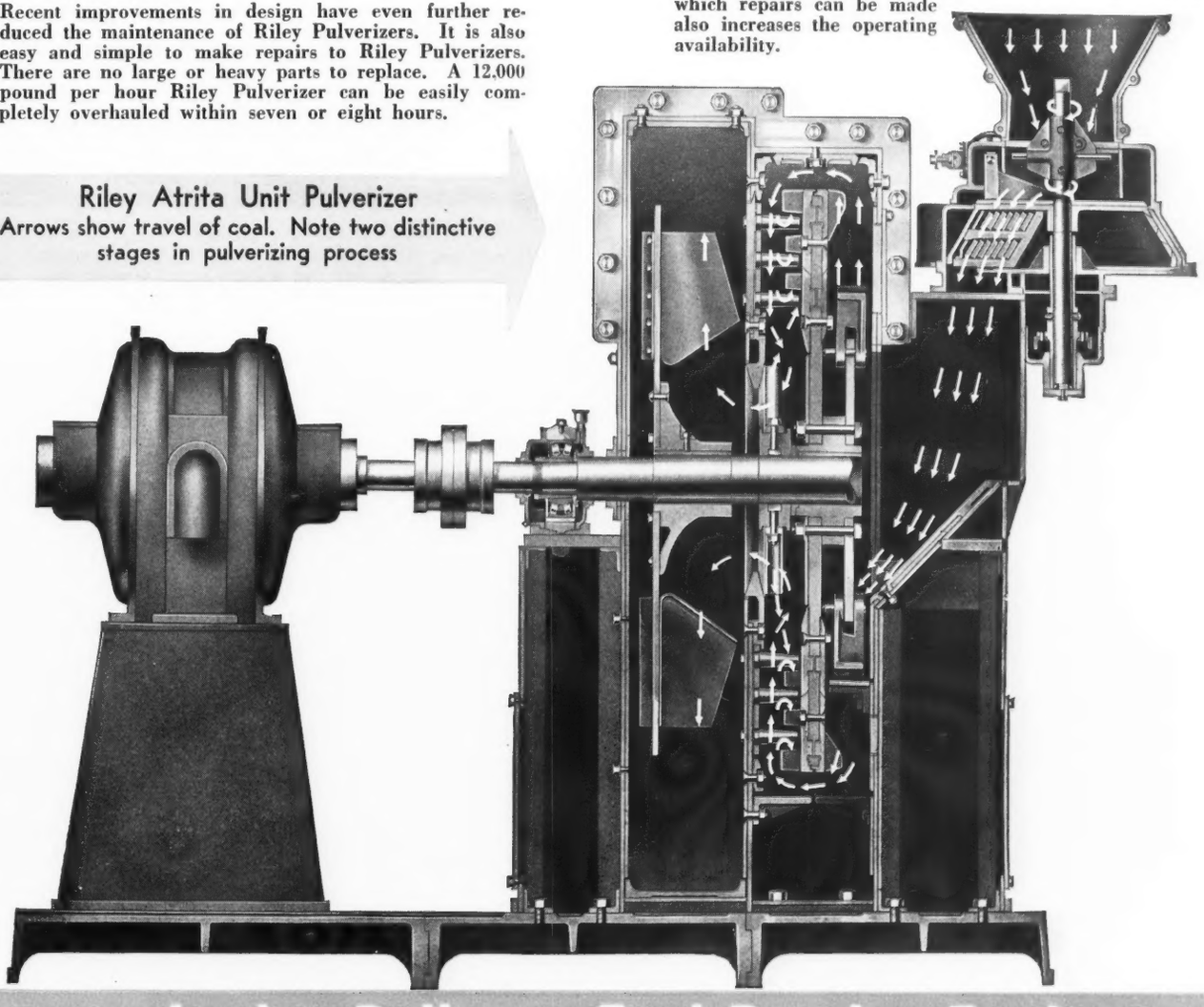
Ease of Lighting

It is easy to light a Riley pulverized coal burner. The design of the Riley burner assures uniform distribution of alternate layers of lean and rich mixtures of coal and air, affording rapid ignition when starting fires. Ignition is seldom lost when starting a Riley pulverized coal installation.

Reliability

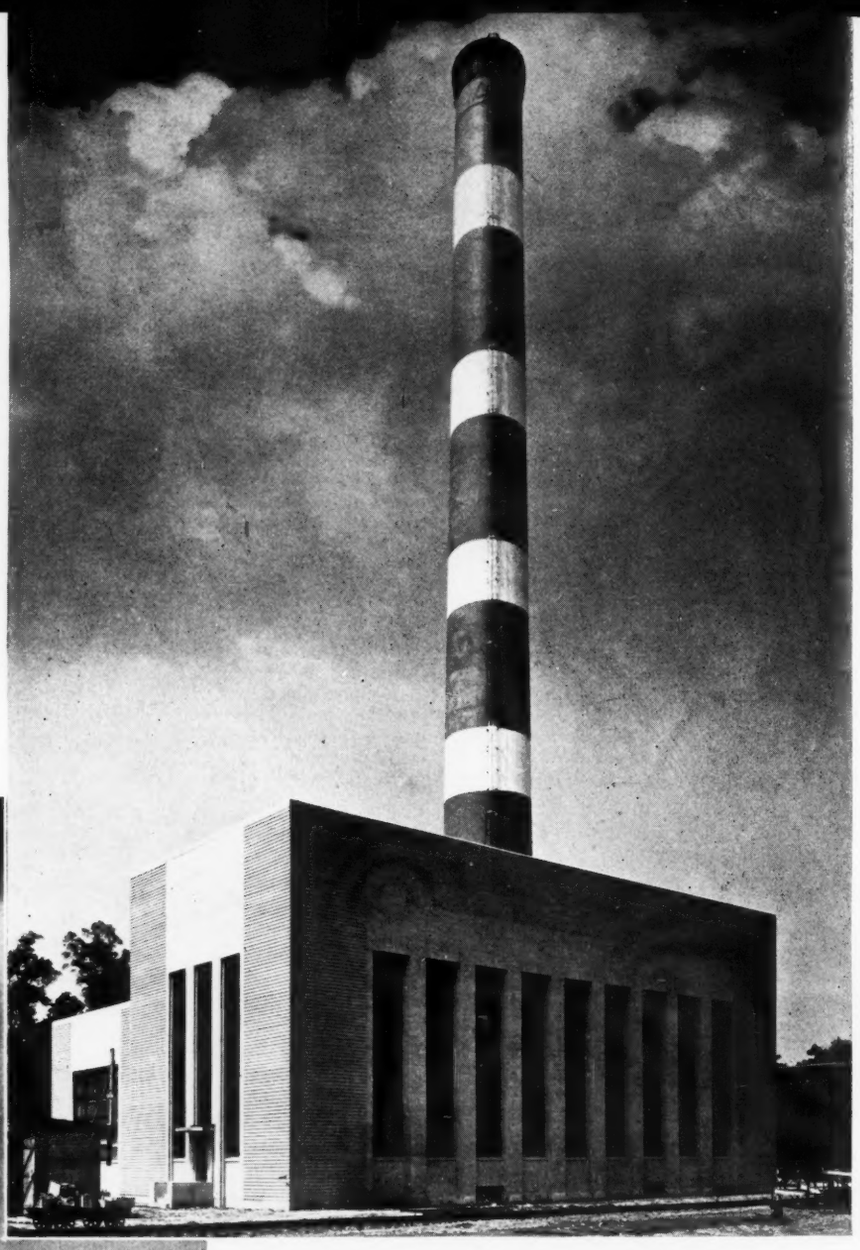
The reliability of Riley Pulverizers has been thoroughly established by performance of hundreds of these machines during the past fifteen years. Plant after plant has operated Riley Pulverizers for years without outages because of mill performance. The speed with which repairs can be made also increases the operating availability.

Riley Atrita Unit Pulverizer
Arrows show travel of coal. Note two distinctive stages in pulverizing process

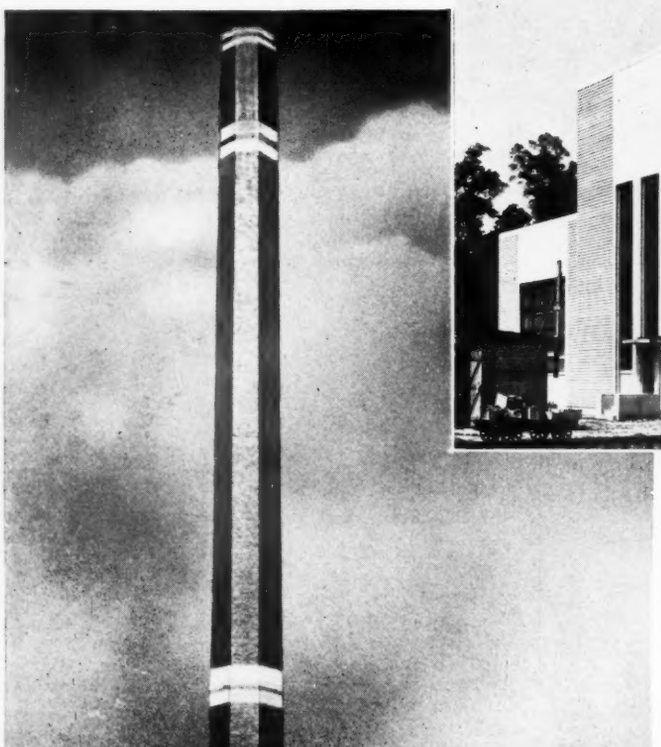


before purchasing Boiler or Fuel Burning Equipment

Well-placed masses and correct lighting characterize this pleasing minimum-cost design. Power house of General Motors Corp, Linden, N. J., houses three gas-fired, 75,000-lb per-hr boilers and three 3000-cfm compressors



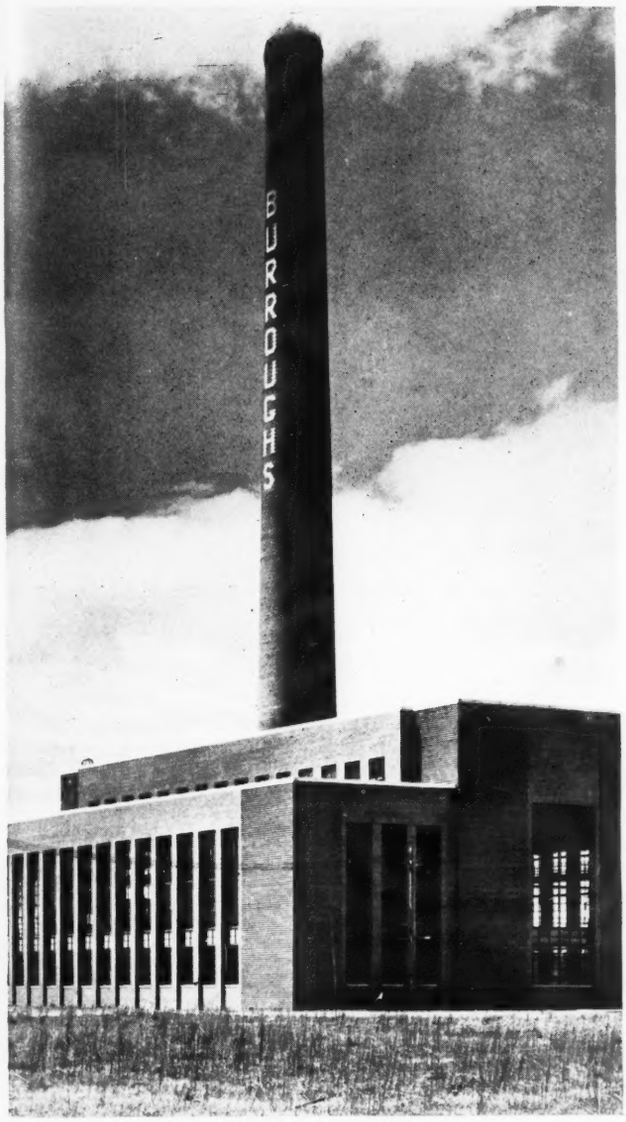
Best Foot Forward



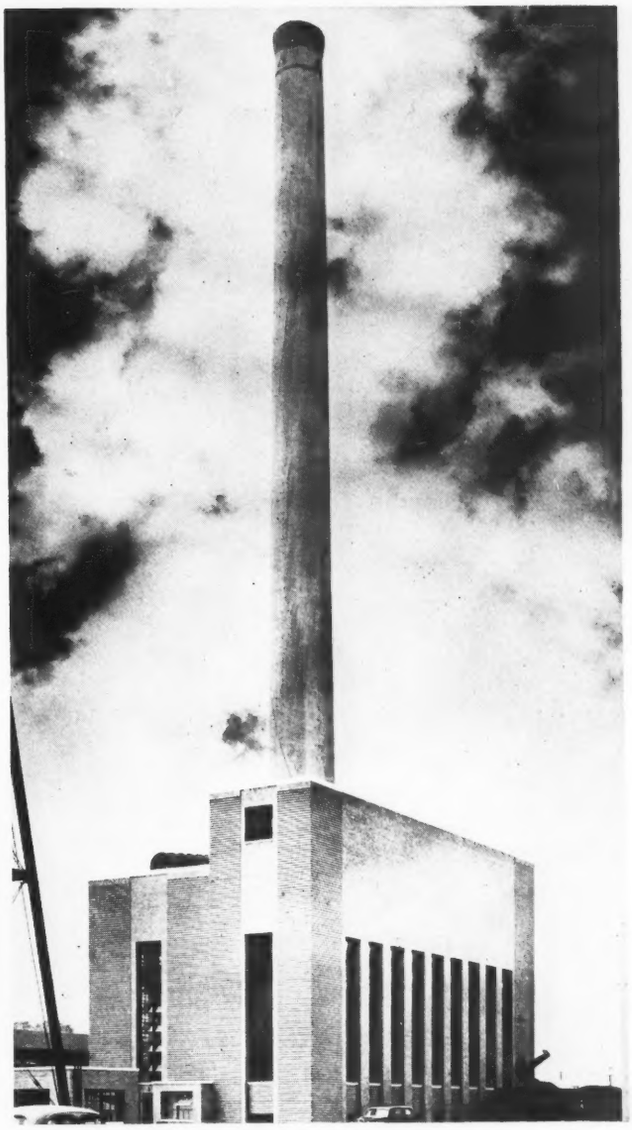
An architecturally designed stack brings a sense of harmony and completeness to this boiler house. Located on University of Notre Dame campus, South Bend, Ind., it contains four 4500-sq-ft coal-fired boilers

MOST MEN KNOW the value of a good appearance; they put their best foot forward when something of importance is at stake. But the same men often fail to carry this sound idea over into industry. They forget that the public and their own employees usually judge their business by the face it turns to the outside world, by its buildings and its grounds.

The incentive to efficient operation and maintenance, the gain in community goodwill, and the advertising value of attractive buildings would easily justify increased cost if it were necessary. Actually, capable designers can develop pleasing elevations at practically no extra cost by skilfully combining ordinary building materials to produce a well-proportioned structure. Pictures on these pages prove it can be done and bear out the often repeated words of their designer, Albert Kahn: "True beauty is developed by a simple architectural treatment based on the functioning of the building."



This economical design harmonizes with architectural features of the manufacturing plant. Two coal-fired boilers and two 1500-Kva mixed-pressure turbines supply power and process needs of Burroughs Adding Machine Co, Plymouth, Mich.



Simplicity and utility mark this building—clean-cut and well-balanced architecturally, but representing its use exactly. Inside, three 200-lb, 6000-sq-ft coal-fired boilers and two 1500-cfm air compressors, serve Chevrolet Motor Co plant, Baltimore, Md.

Photographs furnished by Albert Kahn, Inc, Architects & Engineers, Detroit, designers of the plants and equipment

Often power house and manufacturing buildings can be combined to advantage, as is the case here—Ford Motor Co, Milford, Mich. Power house contains two small boilers, one operating at 200 lb and the other at 600 lb, and provides for future addition of engine-generators to operate at higher pressure

Modern Trapping

DOLLAR for dollar, few modernization programs open to established plants offer the PROFIT POSSIBILITIES of modern trapping with Armstrong Steam Traps. All over the country, plant engineers have found that a small investment in traps pays big dividends in improved service and reduced costs. Numerous engineers have reported saving enough steam to get along with fewer boilers. Maintenance departments report trap repairs cut to just a fraction of former time. Production departments enthuse over the faster and better machine performance secured.

There are some very definite reasons why these benefits usually come to users of Armstrong traps. In the first place, the Armstrong organization goes to great lengths to make sure that you select the right size and type of traps and that you install them properly. In the second place, you get the inherent advantages of the inverted bucket type of trap: automatic air handling . . . water sealed valve . . . no steam loss at any load. And in the third place, you get the exclusive advantages of Armstrong's design features: free-floating valve . . . no wire-drawing . . . large capacity . . . freedom from friction.

Talk it Over With Your Local Armstrong Representative

THERE are more than 40 Armstrong Factory Representatives of long experience in principal centers in the United States, Canada, and Hawaii. These men have been the guiding hands in countless trap modernization projects. Talk over your problems with them. They stand back of every Armstrong trap in their territory and we stand squarely back of them. ARMSTRONG MACHINE WORKS, 812 Maple St., Three Rivers, Mich.

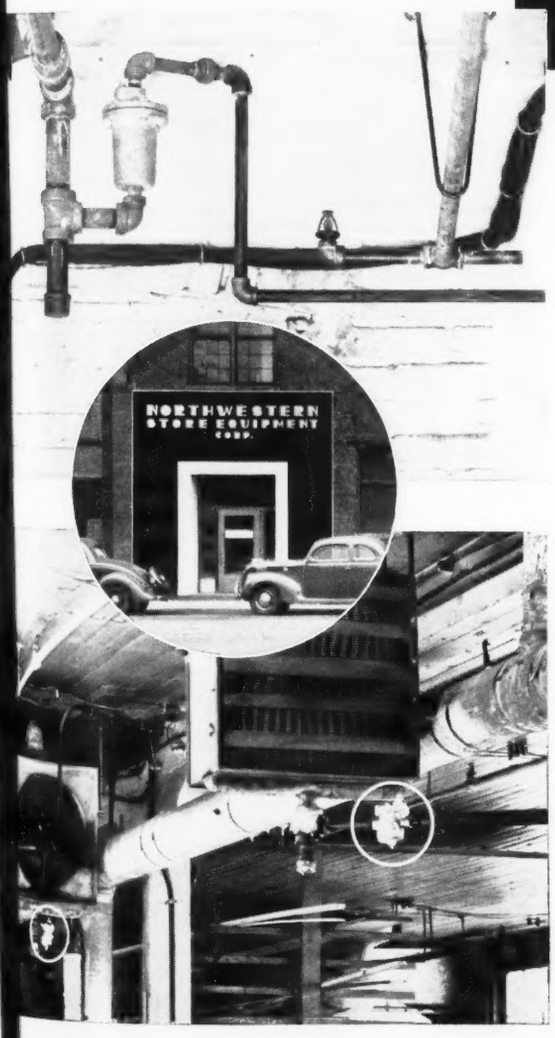
Change over to

ARMSTRONG

PAYS!

A TYPICAL EXAMPLE:

THE accompanying pictures show how Armstrong traps were used to modernize the condensate drainage system in the Northwestern Store Equipment Corporation plant in Milwaukee, Wisc. Below is a short summary of some of the benefits secured. Hamacher & Williams of Milwaukee were the local Armstrong representatives on the job.



BEFORE:

Before. Prior to 1936, Northwestern Store Equipment Corp. used a condensate drainage system that permitted low pressure returns to blow direct to a closed receiver tank.

•

Before. A steam operated lift trap at the receiver tank and a return trap above the boiler were used to return condensate to the boiler.

•

Before. 7 to 10 lbs. back pressure had to be carried in engine room in order to heat dry kilns up to 110° F. in 5½ hrs. time.

•

Before. Prior to 1936 the coal bill averaged:

460 tons of coal per year

AFTER:

After. In 1936, Mr. Armon Diel, Plant Manager, and Mr. Chas. F. Rickert, Plant Engineer, made a careful investigation of modern condensate drainage systems suitable for their needs.

•

After. Twenty-six No. 200 and 211 Armstrong traps were put on dry kiln coils, unit heaters and coil radiation. The lift trap and return trap continue to feed the boiler.

•

After. 3 lbs. back pressure on the engine is all that is now needed to heat the dry kilns up to 150° F. in 2 to 2½ hrs.

•

After. Since 1936 the coal bill has averaged:

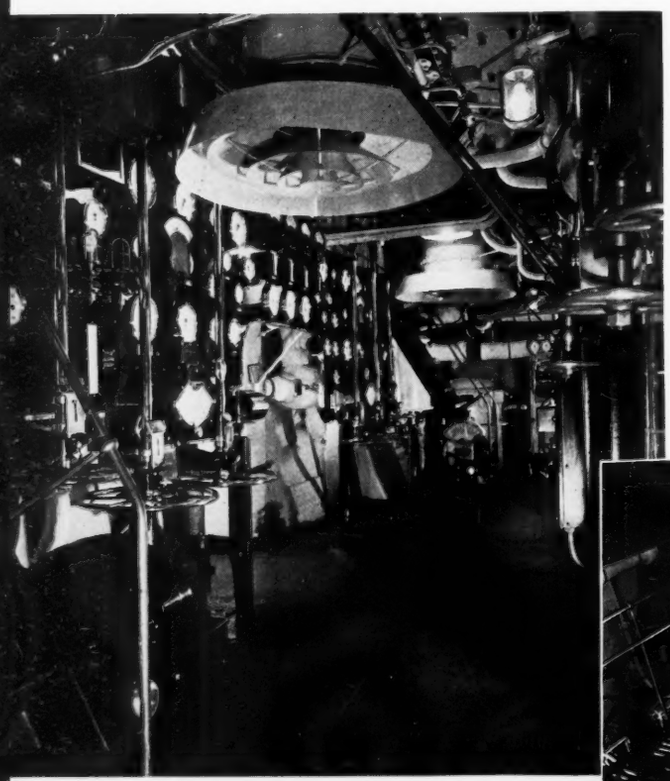
290 tons of coal per year

UNIT TRAPPING

THE NEW MAURETANIA

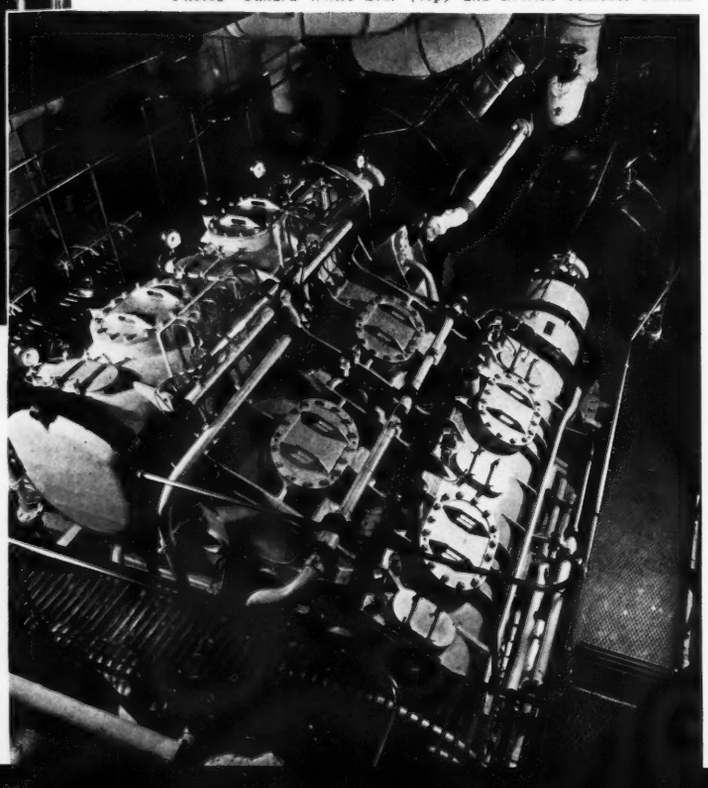
The Mauretania leaving Liverpool on her maiden voyage to New York on June 17

NO SUPERLINER is the latest Cunard White Star ship; she is 772 ft long, 86.5 ft wide, and houses 42,000 shaft hp, compared to the *Queen Mary's* 1018-ft length, 118-ft breadth, and 200,000 shaft hp. She does, however, mark a new class of "intermediate" ship, a special type designed to carry a large number of people across the North Atlantic, not at highest speed, but with the most modern equipment and comfort, and at low cost.



Control and instrument platform. Steam for both main-drive turbines and four 800-kw turbine-generator sets is produced by six Yarrow oil-fired boilers, at 425 lb and 725 F. The emergency generating set is an 8-cyl, 140-hp, 1000-rpm diesel

Photos—Cunard White Star (top) and British Combine Photos



One of the two 21,000-hp main-drive, geared turbine sets, each consisting of a high-pressure, intermediate-pressure and low-pressure unit. These are Parsons combined reaction-impulse type, designed to work with steam pressure between limits of 350 lb g and 0.5 lb abs, at 700 F

THE OPERATING ENGINEER

George Edwards
Advisory Editor

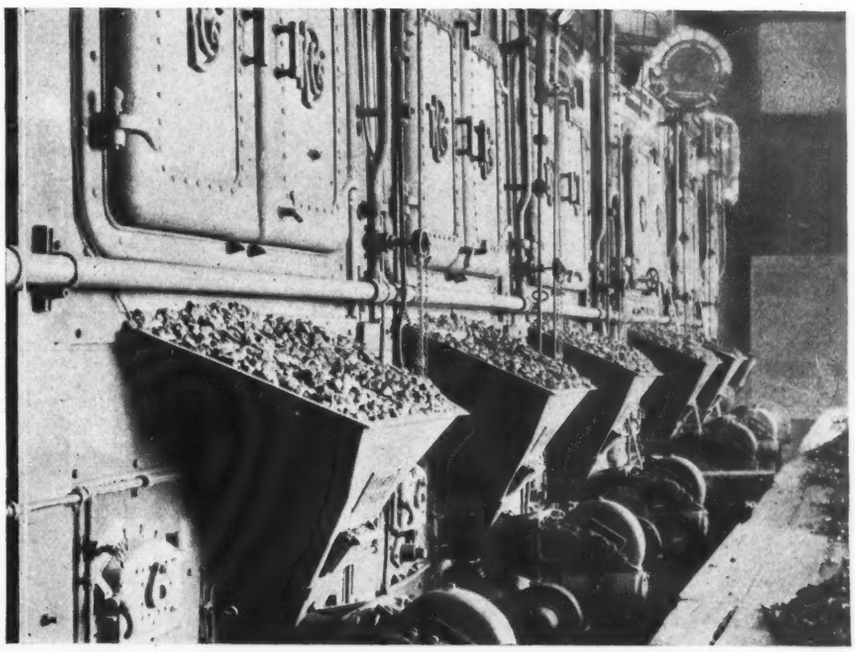
Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

Step-by-Step Improvements Cut Power Costs

John R Evans & Co finds that continuous modernization slashed boiler and condenser maintenance by half, boosted boiler evaporation rate

By ARTHUR B SULLIVAN
Plant Engineer



Six motor-driven stokers boost evaporation rate, increase boiler capacity

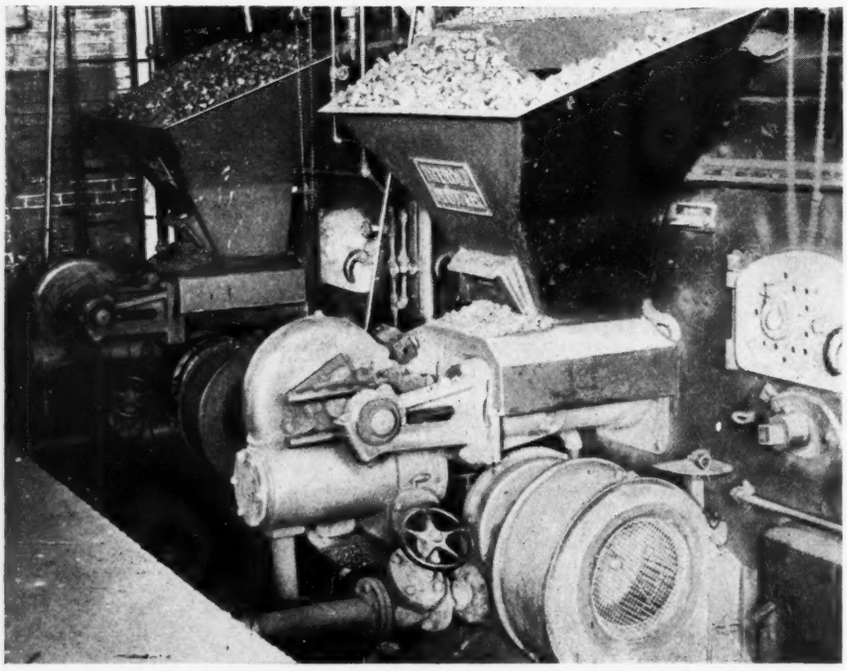
FOR EVERY POWER engineer making big dents in power cost with a new or completely rebuilt power plant, there are many more nibbling away at operating costs through step-by-step improvements. That's the story at John R Evans & Co, leather manufacturers of Camden, N. J., where continuous modernization cut boiler and condenser maintenance in half and, by boosting boiler evaporation rate, automatically brought down steam and electric power costs.

The boiler plant consists of eight 2500-sq-ft Bigelow units supplying steam for process work in the factory and to drive the three G.E. turbine-generators. In the turbine-room, two 750-kw extraction machines exhaust into separate C H Wheeler condensers. A 100-kw backpressure turbine carries small loads and peaks. Excitation comes from a 25-kw motor-driven unit and a 30-kw turbine-driven machine, while a 10-kw turbine-generator serves as emergency exciter and supplies power-house lighting current during shutdowns.

So much for the plant—what about the improvements? First point of attack was the plant water supply, which was a continuous source of trouble. All water, including boiler-feed makeup, came from the Delaware River. In spite of strainers, dirt and impurities in the water caused condenser- and boiler-tube headaches, and strainers themselves had to be taken apart and cleaned at frequent intervals. Installation of two self-cleaning rotative strainers, each capable of handling water from two 2000-gpm pumps, seems to have licked the difficulty.

Porcelain disks with $\frac{1}{32}$-in. perforations make up the rotating drum of the new H A Brassert Co strainers. Raw water flows through these disks during half a revolution of the drum; during the other half, a small quantity of clean water backwashes the disks, thus presenting a clean surface when they again move into the straining cycle. About 5% of the water strained is needed to keep the drum clean. Freedom from upkeep for two years has marked experience with these units and no manual cleaning has been required.

Improvement in water condition shows up in condensers through which



With two turbine-driven stokers, operators can make steam for heating when plant is shut down, without needing to generate electricity

strained raw water circulates before passing to the hot-water tank. Originally, operators had to open and clean the condensers once a week. Now condensers go six months without cleaning.

Boiler Feed

In the same way boiler maintenance was cut, but here some of the credit must go to other changes in the feedwater and boiler circuits. One of these was addition of a clarifying arrangement designed to take the place of blowdown and treatment other than straining. In operation, the Clarifier Corp system continuously draws off small quantities of surface water from each boiler, passes it through an enclosed filter, and returns it to the boiler.

To do this trick, each boiler is fitted with two small motor-driven centrifugal pumps, one of which pumps surface water to main filter line while the other draws filtered water from the return line and feeds it to the boiler. The filter removes suspended solids and by regulating the system the operator can control solids concentration with little or no waste of heat. Likewise by adding a small amount of soda ash during the filtering stage, boiler water can be chemically treated at boiler temperature. Pumps are big enough to circulate in two hours as much water as the boiler holds.

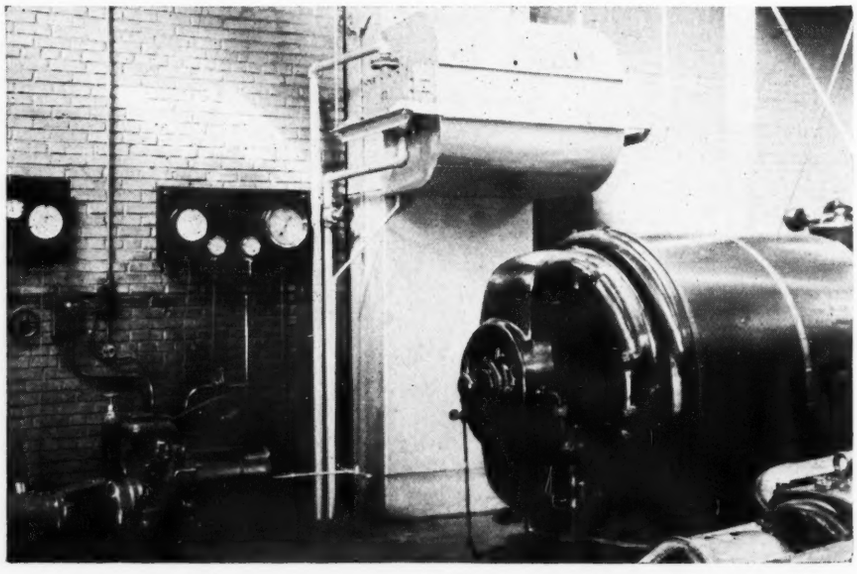
Changes in the water system have overcome a tendency to frothing and made life easier for the operators by spreading the time between boiler cleanings. Where the units went out for cleaning once a month with all the regularity of a good calendar, they can now go nearly a year before tubes need attention. Instead of spending a week or more on hard-scale removal, operators can remove present coating of mud in three days.

Over a period of years, stokers have replaced hand-firing on all eight boilers. On the first six boilers, Detroit single-retort units, motor-driven, handle the firing job but on the last two boilers, turbine-driven stokers, of similar make and type, fit into the plant heat balance. With these units, operators can supply steam for winter heating during weekends when the factory is shutdown, without generating any electrical energy. The small 10-kw generator in the power house can handle all lighting load from the power plant. This combination makes an ideal set-up for handling heating loads during shutdown periods in winter. The hookup with turbine-driven stokers scores another point because exhaust steam from the driving units can be used to keep up temperature in hot-water supply when big machines are shut down.

Installation of stokers brought a real improvement in boiler evaporation. With hand firing, evaporation averaged between 8 and 9 lb of steam per lb of coal. Stoker firing jacked this up to about 10 lb. What's more, stokers boosted boiler output, making it possible to run at 170% over rating.

Steam extracted from turbine-generators and exhaust from stoker and exciter turbines heats water for factory use. A troublesome trap system handled condensate from the hot-water tank, but was replaced by a receiving tank and a small motor-driven centrifugal pump. Level of condensate in the receiving tank automatically regulates pump action.

In the turbine room, biggest improvement has been installation of air-recirculating systems on the two 750-kw turbine-generators. An arrangement of ducts takes warm air from the machines, cools it by passing over cold-water coils, and returns it to the machines. A temperature-actuated alarm signal warns the operators if machines become over-heated. These recirculating systems have eliminated dirt in generator windings and give the operators more of a margin between rated load and loads at which safe temperature is exceeded.



Air-recirculating system for generators keeps windings free of dirt

PICTURE RECORD

THERE ARE AT LEAST five ways to tell a story: words, drawings, tables, curves, photographs. Dan Gutleben (plant engineer, Pennsylvania Sugar Co, Philadelphia, Pa.) uses all five liberally in his famous "Log," subject of frequent mention and quotation in POWER. Dan figures that before-and-after photos come in handy, particularly of equipment that is opened up only at long intervals. Part of a page from his Log, shown here, has some interesting shots of boilers down for annual inspection and overhaul.

Taking Photos

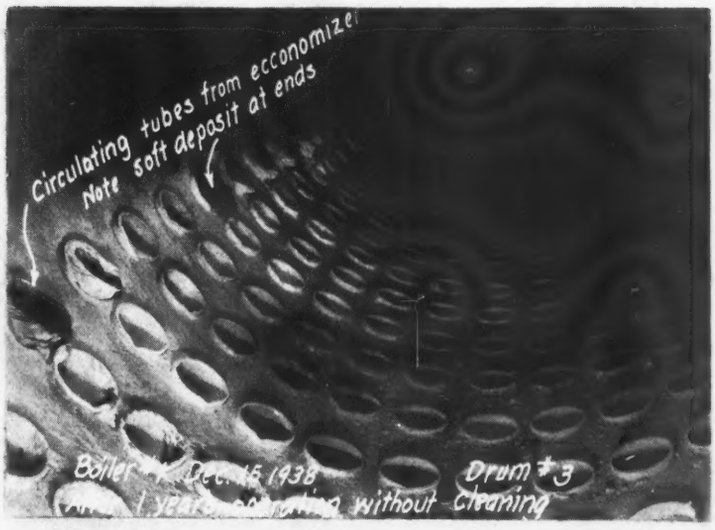
It's easy to take such photos inside boilers. Run a photoflood lamp inside with an extension cord. An ordinary inexpensive focussing camera will do a good job if carefully handled. Stop it down to small opening—at least f 16. A still smaller opening, such as f 32, will give a sharper picture, but requires four times as much exposure as f 16.

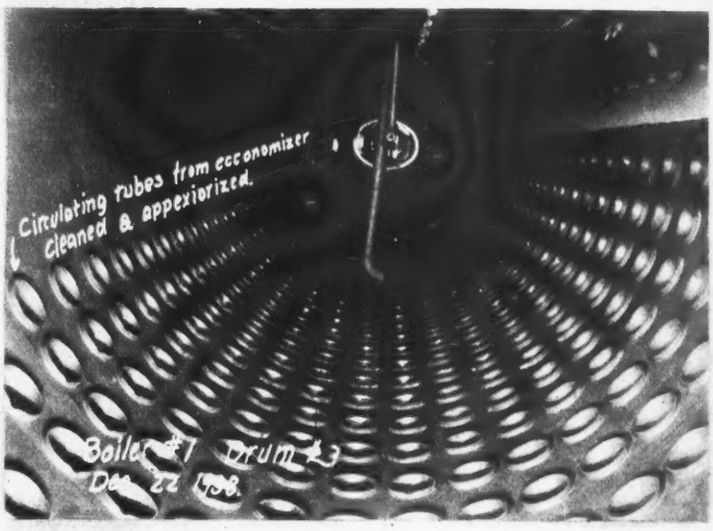
If the camera has no ground glass, set the focussing scale for a point about one-third way from nearest object shown in picture to the farthest. That is, set for 10 ft if nearest point is 6 ft and farthest is 18 ft. Keep camera perfectly still during exposure.

If you don't know much about photography, and can't get help from some photo "fan" in the plant, experiment with three widely different exposures, say 5 sec, 15 sec and 45 sec, each three times as long as the preceding. When you get a satisfactory film, you can make notes directly on it (shiny side) with drawing ink. They will appear as white writing on the print.

Another Gutleben stunt is to group and photograph all the tools required for a given operation (say boiler cleaning). Photos are pasted in his Log along with drawings, tables of specifications, names of manufacturers, prices and all other data that might be useful for future reference. The purpose of the photograph of the tools is to help anybody reading the Log to picture the method of performing the job.

STEAM PLANT
Annual Inspection & Overhaul





George Edwards' Baby

[One of the great satisfactions of an editor's life is the occasional opportunity to give a deserving fellow man a pat on the back. Here's one letter, from S H Coleman, Roanoke, Va., typical of a number we've received, that George Edwards hasn't seen—until now. He selected everything published in this section—except this—which his modesty would have vetoed. We hope our breaking the faith won't prove too great a blow to him, but we thought you'd like to know—The Editors].

"Engineers always like to talk about other engineers—so let's start in on George Edwards. Here's a man who has been philosophizing along for years, giving us good homely truths, showing us our shortcomings and, what is extremely rare, especially among columnists, pointing out ways and means of bettering ourselves.

"I had the opportunity of meeting him personally several years ago, and I was pleasantly surprised to discover one of the most down-to-earth practical men I ever ran across. As long ago as that (and perhaps before) he was sold on, and attempting to sell to others, the idea of a section devoted to the problems of the man in the plant. And from every indication, his years of work have not been in vain.

"So here's to George Edwards, Engineer, and his non-eugenic baby! As far as I, personally, and other engineers to whom I have talked, are concerned, we kind-of like the new kid and are going to do all we can to help him get a break in life."

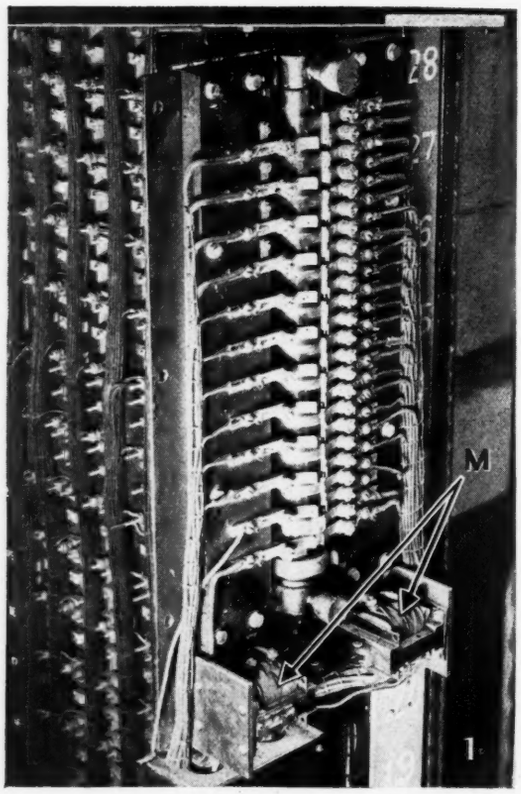


Fig. 1—Old Cylindrical switch

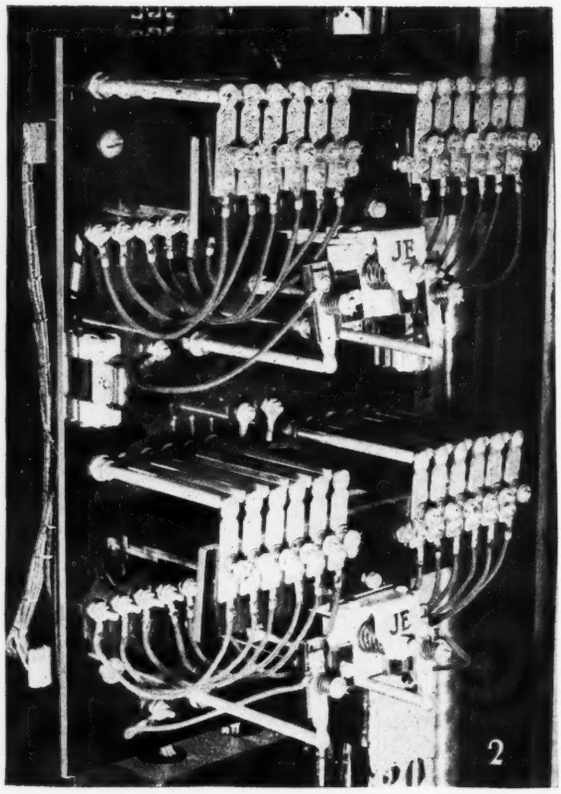


Fig. 2—New contact-type switch

SWITCH IN TIME

By HARRY JACKSON and CHARLES J ELTER

THOSE TWO BUGABOOS, grease and dirt, were giving us plenty of trouble in maintaining efficient operation on our elevators. The up-and-down floor-call transfer switches, one of which is shown in Fig. 1, were cylindrical, with 75 spring contacts resting on copper segments. Cylinders were rotated from one position to another by two horizontal solenoids *M* attached to the bottom end of the cylinder shaft. Square cores in the solenoids collected dirt and grease, tending to make the switches stick.

And to make matters worse, the large number of contacts (75) developed high friction load. So, we decided to do something about this situation—the result was new switches, Fig. 2.

We found, first off, that the number of contacts on each switch could be cut down to 27. Working on that basis, we started in on new switches. Magnet coils and cores were taken from two idle contactors on each controller. Stationary contacts were made from ⅝-in. copper rods with rounded contact ends.

Movable contacts were fashioned from short, flat copper bars, with semi-spherical sockets on one end to contact rounded-off ends of the rods, see Fig. 3. Mountings for contactors and contacts were made of ¼-in. Bakelite.

Copper contacts were bored for mounting screws, and then with a home-made jig, we formed the sockets, Fig. 4. We made the jig from a piece of guide rail and a flat steel plate; the latter clamps the contacts into place on the jig, by a tap bolt threaded into the piece of guide rail. Two pins locate the plate properly on the bottom half of the jig. Holes in the plate served as a guide for boring the two holes in the contacts and for the round-end punch used to form the semi-spherical sockets.

As shown in Fig. 3, contacts are mounted loosely on the Bakelite support, and held in place by springs. These switches, made at low cost, have been trouble-free and require practically no maintenance.

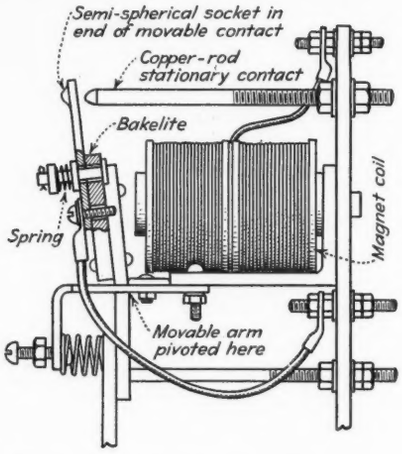


Fig. 3—Construction of contactor

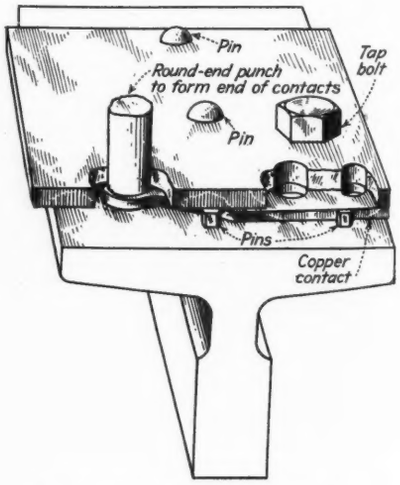


Fig. 4—Jig for forming contacts

If the pocketbook won't permit replacing those old teakettles with new boilers, second-hand equipment may be the answer. Here's the way to get your money's worth

Buying a SECOND-HAND BOILER?

By HARRY M SPRING

OLD MAN DEPRESSION sent many an industrial plant to the showers while others have been able to keep in the game only by cutting down production. One result has been an increase in the number of second-hand boilers on the market.

In contrast to plants that got tough breaks are many that are still in there swinging, but handicapped by boilers that should be replaced for safety as well as economy. New boilers may look like a wild dream, but in many cases an improvement can be made with second-hand units, at lowered cost.

The catch comes when plants needing boilers try to hook up with plants trying to get rid of them. Many states have strict laws dealing with relocation of boilers, many second-hand boilers offered for sale do not meet the requirements of the law in these states, and many are unsafe for operation in any state. For any particular plant, some boilers offered for sale will not fill the bill, while others are obsolete and uneconomical for operation in any plant. How is the would-be buyer to find his way through this apparent tangle?

While not typical, our friend knew what he wanted and got his money's worth

The First Step

Regardless of state laws or other factors, the first step is to get a list of available units, bids on their cost (including installation), and complete specifications. In setting down requirements, first things to consider are pressure and capacity, in thousands of pounds of steam flow per hour. Think of three things when considering capacity—peak output, normal output, and variations in output.

Pressure limitations will take care of the first eliminations; over 150 lb means a watertube boiler, between 100-150 lb, either a firetube or watertube may be considered, and below 100 lb a firetube boiler is usually preferred.

The range of 100-150 lb offers most possibilities in selecting a replacement boiler, so let's narrow this field down. Available floor space and head room will carry most weight.

Small floor space and plenty of headroom almost automatically calls for a vertical boiler. If capacity requirements are low, say 4000 lb per hr, and load variations are moderate, almost any of the vertical firetube boilers will fill the bill. Somewhat better efficiency can be had, however, with any of several types of 2-drum vertical watertube boilers. The latter are better fitted to carry a fluctuating load without carryover of moisture and surface scum, due to greater steam-disengaging surface. This type also stands better high furnace temperatures met with fuels burned in suspension, such as oil, gas, or pulverized coal.

Low head room with moderate floor space limits choice to a horizontal firetube boiler, or a low-head watertube boiler. The latter type is a fairly new development, and probably few are to be had in the second-hand market.

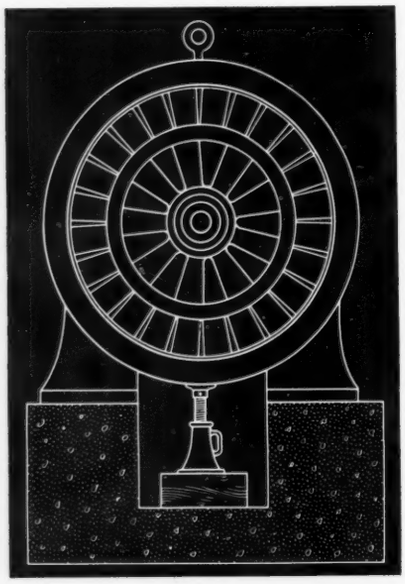
When desired output is less than 3500 lb per hr, economical choice usually leads to a firetube boiler; if in excess of 4500 lb per hr, a watertube boiler will usually get the call. Price will have considerable bearing on choice of watertube type, as will suitability to available space. In arriving at a decision, several points of adaptability should be considered.

Bent-tube, multi-drum boilers are usually better suited to extremely fluctuating loads, due to greater water-storage capacity. With moderately fluctuating loads, and for higher pressures, a single or double-drum boiler is cheaper and will usually do the job. For oil, gas, or pulverized-coal firing, the narrow furnace of longitudinal single-drum boilers may mean higher sidewall maintenance. A cross-drum type is better suited to these fuels and firing methods.

Many states have laws forbidding reinstallation of boilers of certain construction. A boiler stamped ASME Standard, or National Board, will be acceptable in practically all localities. However, the state or city department of boiler inspection should be presented with complete specifications and history of the boiler or boilers desired.

After the local department has been consulted in regard to acceptable standards of construction, a complete internal and external inspection of the boiler to determine type and extent of any defects will be necessary. This examination should be followed by a hydrostatic test of the boiler to one and one-half times its maximum allowable working pressure. Inspections and hydrostatic test should be made by a certified boiler inspector holding a commission for the state or municipality in which it is desired to install the boiler. If it is in a district having no boiler code, a competent inspector may be engaged from a company specializing in boiler-plant insurance.

PRACTICAL AIDS TO OPERATION



Screw-Jack Stops Generator Breathing

ONE POWER PLANT with which I was connected contained two unaflow engines direct connected to 350- and 750-kw alternators. We noticed that the stator of the 750-kw alternator was breathing in time with strokes of the engine. Not knowing exactly what to do, the operator picked up a little more load on the machine, which stopped the movement. When load was dropped later in the day, before removing the unit from the line, the breathing increased.

We called in a manufacturer's service man. He watched the generator for a while, then asked for an ordinary screw jack and some blocking. He put the jack in the generator pit and screwed it up tight against the bottom of the stator.

When the unit went back into service it showed no signs of breathing and was operated with the jack in place for several years until the machine was removed. It seems that the stator had settled or sagged out of true round enough to affect seriously the air gap. The strain taken by the jack corrected the fault.

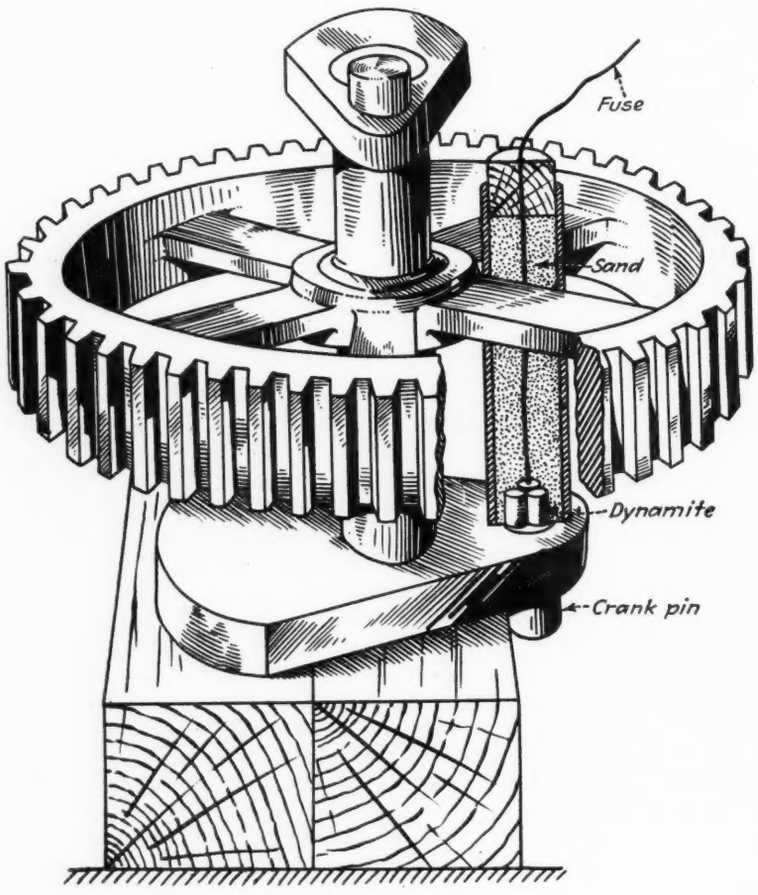
St. Paul, Minn. E R WEBBER

Crank Pin Removed With Dynamite

FACED WITH THE PROBLEM of removing the crank pin from a large pipe-line-pump crankshaft in a remote section of South America, I resorted to dynamite when other means failed. To do the job, we took the gear and crankshaft out of the pump and blocked the shaft vertical, as in the figure. Then a charge of 3 quarter sticks of 60% dynamite, tied together and carrying a fulminate cap and fuse, was centered on the pin end where it came flush with the crank arm. To hold the charge in place, we set a small amount of plastic gasket material around the base of the dynamite cylinders.

A section of drill pipe placed around the charge, as shown, protected the gear from damage by the explosion. When the pipe was properly centered around the dynamite, we filled it with dry sand and screwed a wooden plug into top end of the pipe. The fuse was brought out through a hole in the center of the plug. Planks were then laid around the gear to protect its teeth and we tied a sloping plank up against the upper crank to guard against possible contact with the section of drill pipe after the dynamite went off.

Detonation of the charge lifted the section of drill pipe out of the gear, without removing the wooden plug, and dropped it onto the floor. The crank pin was forced out and into the clay floor from where it was dug out, unharmed, as was the bore in the crank throw. Once the pin was out, it was easy to build it up by welding and true it on a lathe. A piece of drill rod connected to a rope and pulley served as a



drop hammer to force the finished pin back in place. Using dynamite for removal of the pin is pretty drastic and probably can be recommended only under such conditions as we used it, but it did the trick.

Kilgore, Texas C C LYNDE

Test Availability of Spare Machines

THE IMPORTANCE OF KNOWING that spare power-plant machines are ready for use when needed cannot be overemphasized. Spares can be divided into two general classes: first, duplicate of regular units; second, units performing similar services but having different characteristics or drives. Availability of duplicate machines can be pretty well assured by alternate operation, changing from one to the other daily or weekly. With the other type of spare, plant economy or ease of control may dictate running the main units continuously, holding the spare in reserve for emergencies or special conditions. This class of machine must be tested frequently to be sure it will be ready for service when needed.

In one industrial power plant, spares are operated or tested according to schedule. Operators responsible for doing these jobs are required to fill out a special log sheet. Since testing and changing-over equipment is done by one shift during week-end light-load periods, responsibility is fixed. The log sheet enables all concerned to see at a glance whether the work has been completed.

Roanoke, Va. S H COLEMAN

SOFTENER-ROOM LOG SHEET

Date	Time	Treated Water H	P	M	O	S	N	Treatment Lime	S. Ash	Backwash Filt. No. 1	No. 2	Blowdown Softener
Oct. 10	1 A.M.	0.5	1.9	3.8	0.0	3.3	3.3	40	18		X	X
	5 A.M.	0.4	1.3	2.7	-0.1	2.3	2.4	—	—			
Oct. 11	9 A.M.	0.5	0.9	2.7	-0.9	2.2	3.1					
	1 P.M.	0.4	1.3	2.7	-0.1	2.3	2.4	40	18	X		X

Raw Water Tests Date	H	G.P.	M	H-M	Cl.	Time
Oct. 10	5.3	3.8	5.0	0.3	0.5	9 A.M.
Oct. 11	6.0	4.5	4.8	1.2	0.5	9 A.M.

Remarks

Changed orifice to 13/64" on October 11 at 2 P.M.

A Log for Boiler-Feed Treatment

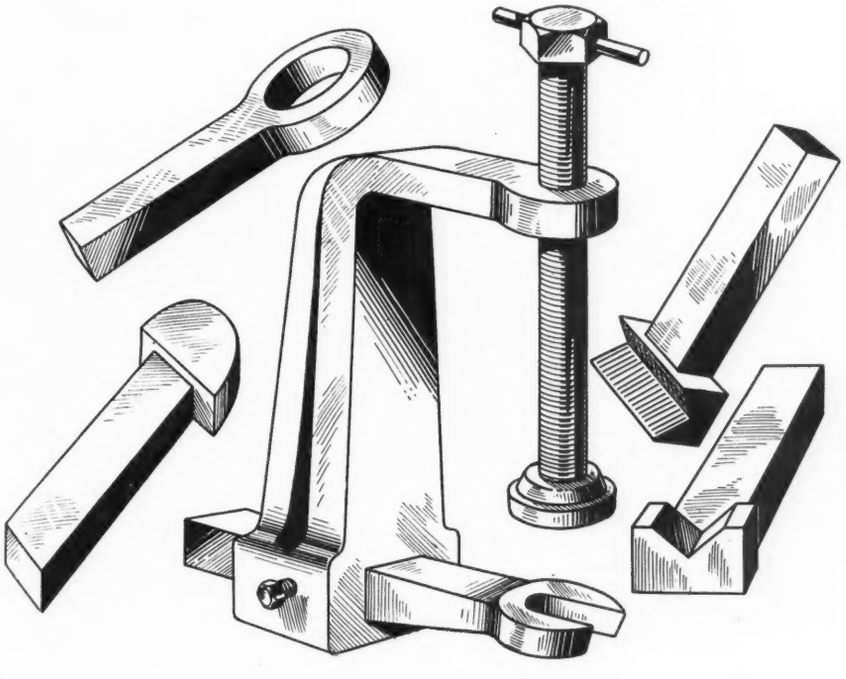
WE RECENTLY INSTALLED a new boiler in our plant and a hot-process lime-soda water softener. At first, the operators had trouble handling the softener process satisfactorily. Finally we adopted a regular system of testing and entered the results on the log sheet (see figure). When the operator began to understand the importance of the various readings, results became satisfactory. The symbols on the sheet denote the different tests made on the water.

Hibbing, Minn. A L BENNETT

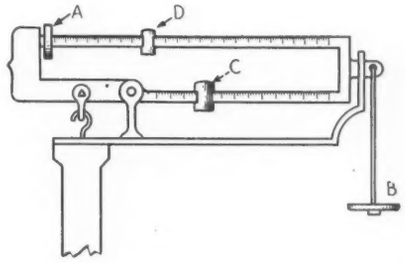
A Jaw Clamp That Will Do Any Job

HERE IS A SHOP CLAMP that will be hard to beat for all around usefulness. It is a product of shop invention born of a need for a maintenance man's kit that can be carried around the plant. Most any type of jaw to suit any kind of clamping job can be made and used. Four of these jaws I have found most useful are shown. A set screw secures the jaw in place as indicated on the assembly below.

Boston, Mass. L W ROGERS



Small Weighing on Big Scale



A SMALL SCALE was not on hand for balancing induced-draft-fan rotors in our new boiler plant, so I used a heavy platform scale to weigh the balancing material accurately. Here's how: First I balanced the rotor with a test weight. Next I placed a 50-lb scale weight on the beam at *A*. Then, the test weight required to balance the fan rotor was placed on the scale at *B*.

The next step was to balance the beam by adjusting weights *C* and *D*, using *D* for accurate adjustment. When the beam was in balance, I removed the

test weight from *B* and substituted the piece of flat steel to be used to balance the fan blade. I trimmed this down a bit at a time until the beam was again in balance, then drilled it for fastening to the fan blade. By attaching the balance piece in this way, no allowance had to be made for the weight of the attachment, as would be necessary with welding.

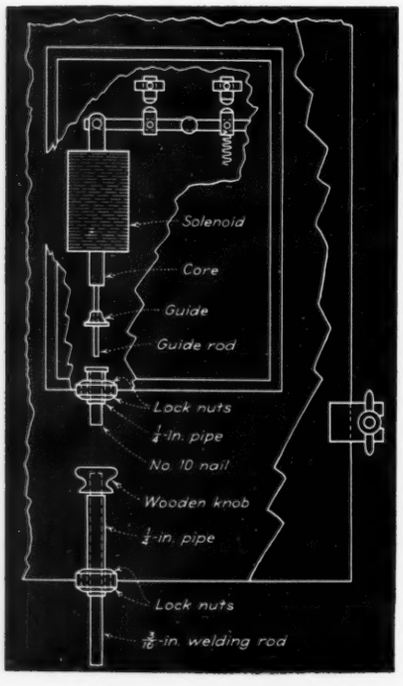
Sydney, N. S. A W LINES
Dominion Steel & Coal Corp, Ltd

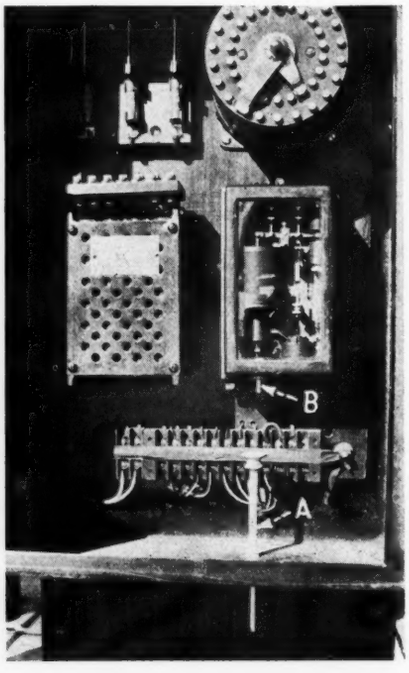
A Little Push Tests Regulator

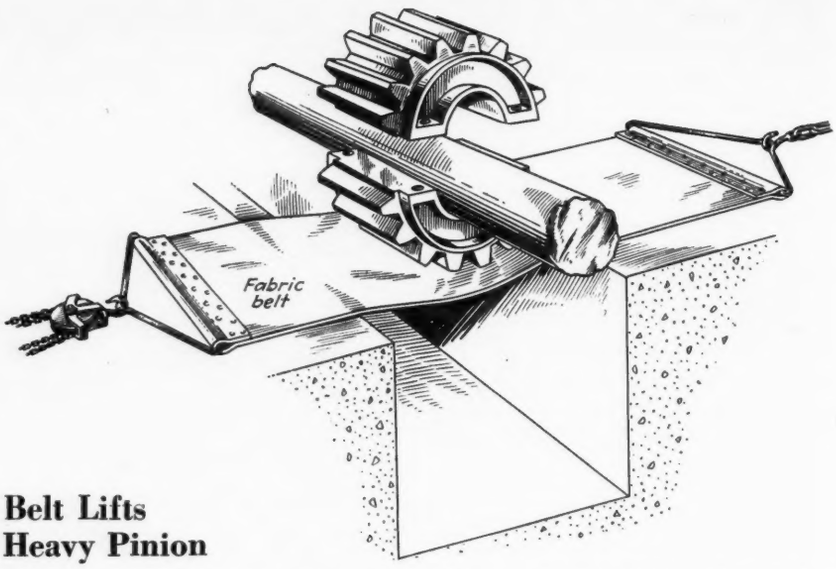
TO MAKE SURE that induction voltage regulators on our power line were in good shape, we decided to test them each shift. This required opening the control case, raising the solenoid core to boost the voltage, then releasing the core to see how quickly the regulator would bring voltage to normal. Opening the regulator case was inconvenient and let dust in that might cause trouble. The diagram shows how we solved this problem.

Below the guide rod in the solenoid core we inserted a short ¼-in. pipe nipple in the regulator case and held it in place by two nuts. In this nipple we put a section of No. 40 nail with the head on top. Below the nail we put in the outside casing a short section of ¼-in. pipe to hold a section of 3/16-in. welding rod with a wooden knob on its top end. The photo shows the regulator with the testing device installed at *A* and *B*. Now, to test the regulator all we do is push up on the end of the welding rod and this motion is carried to the solenoid core by the nail, without opening the regulator case.

Kearney, Neb., WILLIAM KNOLL, JR





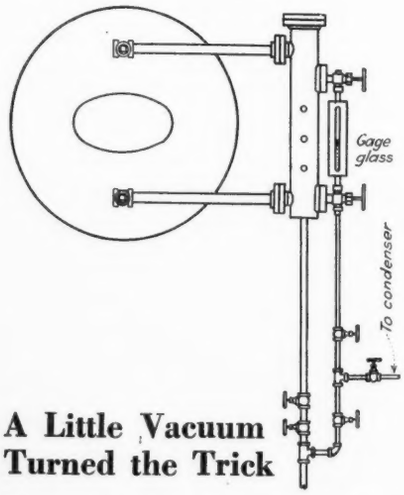


Belt Lifts Heavy Pinion

AN EASTERN rubber plant worked out this kink for mounting heavy split pinions on main-line shafting. Line shafts for rubber machines range from 4- to 8-in. diameter and run along top of concrete floor troughs 25-in. wide and 36-in. deep. A typical split pinion for a 6-in. shaft is 2½-in. circular pitch, has 25 teeth and 12-in. face. Total length, including clamping ends, is about 24 in.

Since the pinion weighs several hundred pounds, it is difficult and dangerous to handle without mechanical aids. A support was made of 6- or 8-ply fabric belt and ¾-in. rod, as shown in the figure.

Drawing shows method of use. With fabric band hooked in place about as indicated, but slack, mechanics slide lower half of pinion down band into approximate position. They then tighten chain fall to lift lower half of pinion up against shaft. Next they set upper half of pinion on shaft directly above lower half. They insert studs in holes and take up nuts loosely. To complete mounting, they twist pinion until keyways match, insert key and tighten nuts. FIELD EDITOR



A Little Vacuum Turned the Trick

SOME TIME ago, the gasket under a flat-type gage glass on one of our high-pressure boilers began leaking. When we tried to replace the old gasket with a new one, we found that the bottom gage valve was leaking badly.

After several unsuccessful attempts to replace the gasket, we were faced with either stopping that leak or taking the boiler off the line. We ran a pipe connection from the gage-glass blowdown line to the suction line between

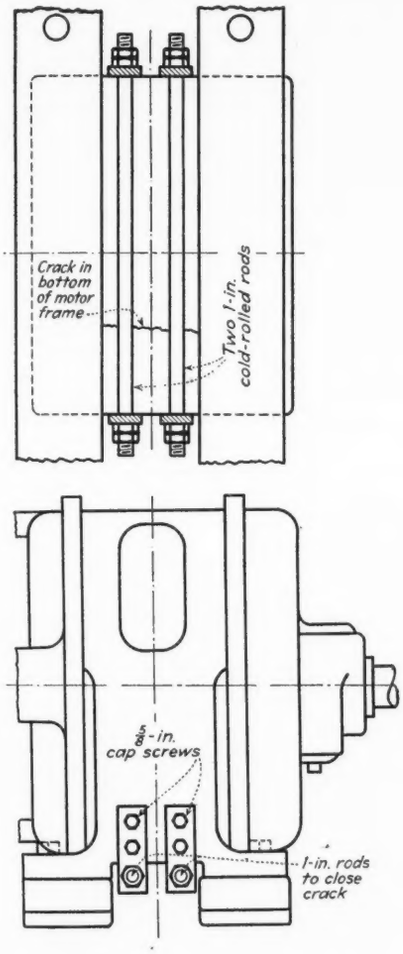
the inter- and aftercondenser and the main condenser on one of our turbines. By starting an extra set of jets on the inter- and aftercondenser, vacuum loss was very slight, and we had no trouble fixing the leak.

Greenwood, Miss. B Y BUCKLEY

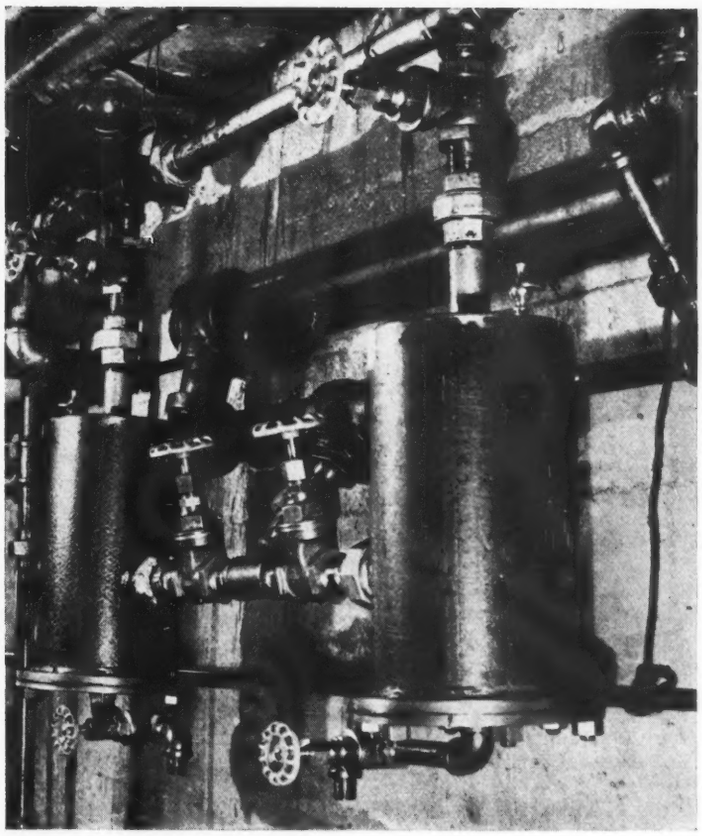
Bolted Job Saves Motor Frame

A TEMPORARY REPAIR that we made on a 150-hp slip-ring motor became a permanent job. The cast-iron frame of this motor cracked from end to end in its bottom center. A welding repair was not practical so we decided to use 1-in. cold-rolled rods, threaded on each end to pull the frame together.

We cut four pieces of flat steel, ¾ x 2 x 10 in. long and fastened two on each side of the motor frame with ⅝-in. tap bolts, as in the figure. Through holes in the free end of these pieces we put the 1-in. rods. After loosening the bearing bracket bolts, nuts on the rod were tightened until we could scarcely see the crack. This job worked so well we decided that a new frame was not necessary, thus saving its cost.



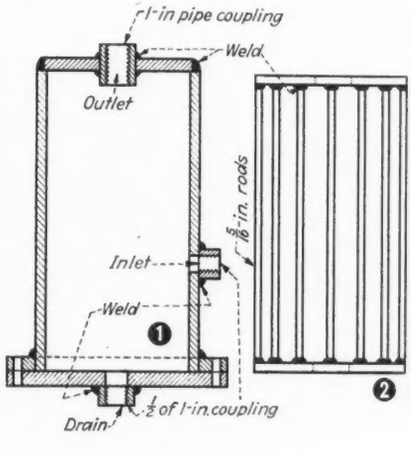
Rockford, Ill. NELS W OMAN



Welded Filters for Fuel-Oil Line

WE RECENTLY MADE and installed fuel-oil filters for two diesel engines, see photo. For casings we used pieces of 6-in. pipe 1 ft long with a top plate welded in and a bottom plate bolted to a flange. To serve as an outlet connection and to center the filter bag, we placed a 1-in. pipe coupling about ½ way through a hole in the center of each top plate and welded it into place, as in photo above and drawing.

Around a hole in center of the bottom plate we welded ½ of a 1-in. coupling for a drain connection. One-half of a 1-in. coupling was also welded around a hole in the side of the cylinders for an inlet connection (Fig. 1).



We made a form for each filter bag by welding twelve 5/16 in. rods between two disks, Fig. 2, of smaller diameter than the inside of the filter casing. To these rods we soldered 60-mesh screen wire, over which the filter bag was tied with draw strings. This permitted changing and cleaning the bags.

Kearney, Neb. HAROLD MOHLER

The Iron-Cement Mystery

Coming on the job one night shift I found a newly made flanged joint in a large air line leaking badly. During the night I filed a screw driver to form a calking tool and with a light hammer calked the pipe thread with copper wire just outside the joint and stopped the leak.

To have a little fun with the day engineer I filled around the end of the joint with iron cement. Next morning he was surprised to find the leak stopped, and even more so when he found that the repair had been apparently done with iron cement. He probably still believes that I used some special method of stopping the leak with this cement while pressure was on the line.

Riverdale, N. Y. ALEX GRAY,
Chief Engineer
Colored Orphan Asylum

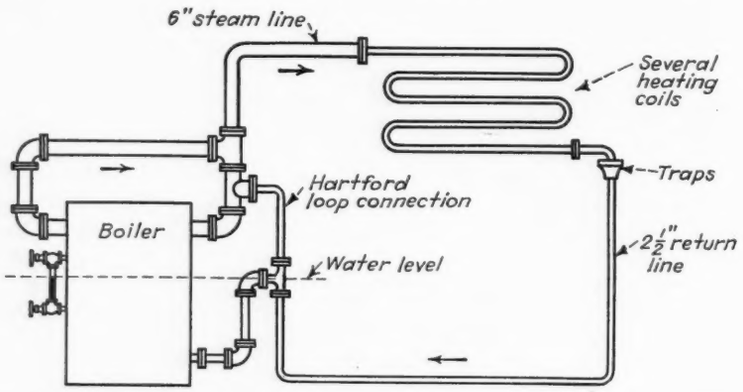
READERS' PROBLEMS

Questions for Our Readers

Heating-Coils Return

Question 1

AS SHOWN IN THE SKETCH, *our plant has a Hartford loop on return lines from heating coils. Return enters boiler at water level. There is a condensate line directly from steam line to return line. I think that this loop retards water return to boiler and allows water to remain in heating coils, thereby lowering my heat efficiency at heating coils. Can any* POWER *readers offer suggestions?*—WFC



Will Engine Pay?

Question 2

WE ARE CONSIDERING *the purchase of a 60-kw engine-generator set to supply our daytime factory load from our existing 125-lb pressure boilers. We have to carry 125-lb for a small part of the process but most of the steam is used at 15 lb g. We are now buying hydro power averaging about 3¢ per kwhr including service charge. Coal is $6.30 a ton. Should we spend about $3000 for the engine installation?*—SS

SUITABLE answers from readers will be paid for if space is available for publication. Answers accompanied by practical drawings or photographs will command additional pay.

Kerosene for Scale?

Answers to July Question 1

The Question

ON TAKING CHARGE *of a small plant recently, I opened three hrt boilers for cleaning and inspection and discovered heavy deposits of mud on tube sheets, back end of shell, and especially thick on rear flanges and seam covering rivets. Boilers were installed in 1917. The accumulation is rock hard, and I can see no way to reach it with hammer and chisel. In spite of the salesman's promises, a feed-treatment product failed to do any good.*

A friend of mine, who has operated boilers for many years, claims that a gallon of kerosene put in boiler with water treatment would get in back of deposits and force them away from shell. Regular use of kerosene has kept his boilers clean as new without doing them any harm. However, I'm afraid of getting any kind of oil in boilers so I'm not jumping at the idea. Can POWER *readers tell me if this is a good suggestion and if it isn't, how can I go about removing or dissolving this scale?*—FS

May Cause Accident

USE OF KEROSENE in boilers is to be discouraged, as serious accidents have resulted from its use. It is customary practice to fill boiler to within 8 in. of top of shell, leaving top manhole plate off, and then to pour in solution of about 35 lb caustic soda and an equal amount of soda ash. Light a slow fire, and allow boiler water to percolate for roughly 48 hrs (with manhole cover still off). Draw fire, cool boiler, drain, and hose out heavy sludge. If necessary, repeat every month until heavy scale is gone.

Grand Rapids, Mich. J M GORRIE

Treat One at a Time

FS CAN USE penetrating qualities of kerosene to good advantage in his boilers, but he must be cautious. Chances are good that first applications will cause every boiler tube to leak.

If FS has a spare boiler, I suggest that he treat one at a time: wash thoroughly, put ½ gal. of kerosene in boiler while empty, fill boiler to proper level with water. Start a fire and bring pressure up to 50–60 lb. Keep it there for a few days (or until leaks develop), then empty boiler, wash it and inspect. If scale seems to be softening and if water blown out is dirty, FS can proceed again as before, possibly increasing dose to 1 gal. Repeat until boiler condition satisfies.

If FS has no spare boiler, he can take one boiler at a time, use one quart of kerosene and lay the boiler off each weekend. I strongly advise against feeding kerosene through feed pump to all boilers at one time, until all are cleaned and tight.

Waterbury, Conn. F W CARTER

Good Results with Proper Procedure

KEROSENE has long been popular for removal of hard scale, and when applied properly gives good results. Empty and dry boiler as kerosene won't penetrate satisfactorily when surface is wet. Apply kerosene through top manhole with a syringe, or use an ordinary fire extinguisher, reaching as many parts as possible. Use 3–5 gal. per 1000 sq ft of boiler surface. Kerosene will run down tubes and collect in bottom drum.

Close boiler, and slowly fill to above working level, using hottest water available. This procedure deposits kerosene on all internal surfaces. Start a slow fire and, with only the vent open, allow to boil for 24 hrs at least. Allow 2–3 hrs for cooling and then empty rapidly. Open up and remove scale from all heating surfaces and wash out thoroughly with a high-pressure water hose. Process may have to be repeated in a week or two depending on condition of boiler.

There is no danger in using kerosene in this manner. Only possible objection is that steam will carry strong odor of kerosene for a few hours; this might be bad if steam goes to process.

Kearney, N. J. G M MCNALLY

It Worked in France

IN A POWER PLANT taken over by the Corps of Engineers, U.S.A., during the late war to end war, we used kerosene to clean out scale deposits which had caused the French to condemn the units and to dispose of them (at profit) to their allies from across the sea. We filled the boilers with kerosene some 6 in. deep, which was about halfway up the sides of the worst scale deposits as shown by flashlight surveys.

Boilers were then warmed (not heated enough to gasify the oil or burn unprotected metal) and then left for 72 hours. Kerosene penetrated between scale and rust layer on boiler steel itself to such an extent, that after draining off kerosene, most debris broke up and was worked to the clean-out with a steam jet. As soon as the scale was removed, boilers were put to work without trouble from the remaining kerosene. Incidentally, we filtered the kerosene, and sold it back to the French!

Being in a hurry, no one bothered to

check the nature of the scale, but it could not have been an easily removed material or the French would never have sold the boilers to the U.S. As I remember it, the debris hauled away was flaky and rather brittle, much like some forms of shale, and there was enough to fill a wheelbarrow several times over.

Since this first experience with kerosene, I have watched it do a good job in cleaning old deposits from river-steamer boilers.

Longview, Texas M T PATE

Kerosene O K

I SUGGEST that FS use kerosene as follows: empty boiler while water is still hot then remove manhole plate and throw in about 5 gal., aiming in direction of rear flanges and heavly incrusted seams. Be sure blow-off valves are closed. Start filling boiler slowly, taking about 24 hrs to allow time for distribution of kerosene over interior surfaces.

FS should then empty the boiler and go into the back connections and the furnace with a good heavy hammer (about 3 lb). Wherever he knows there is scale, he should give the plates a thorough hammering. Combination of kerosene and pounding will loosen scale, and after washing out, boiler will be ready to go. Small amount of kerosene will cause no trouble as it is too light to cling to boiler surfaces and cause overheating.

Springfield Gardens, N.Y. J C O'BRIEN

Mechanical Removal Only Solution

KEROSENE may be of some value when scale will permit penetration, but some scale is too dense for any liquid practical to use. About the only danger with kerosene, in moderate amounts, is possibility of ignition if vapor in open shell or drum comes in contact with open light or spark.

In FS' case, I see no practical solution but mechanical removal. I assume his hrt boilers have a manhole in the upper part of shell or head. After removing a vertical lane about three tubes wide, a man can enter and chip out scale with hammer and chisel, or better yet, by pneumatic drill. Careful work will avoid excessive scoring of plate or rivet heads.

Canton, Mass. H M SPRING

Use Inhibited Acid

FS IS RIGHT in not jumping at the idea of using kerosene regularly in his boilers. A better procedure would be to cook mixture of kerosene and an alkaline salt in the boiler while it is off the line for a week or so. Use about 20–25% kerosene by volume and about 50 lb of soda ash or equivalent alkali, per 1000 gal. of water. This method works well on sulphate scales.

A still quicker and more effective cooking method involves circulating for 6–24 hrs. a solution of about 1–2.5% pure HCl and a corrosion inhibitor to protect boiler metal. Commercial muriatic contains about 28% pure HCl. To check this method, take a few small pieces of the scale in a test tube and add some concentrated muriatic acid. A violent bubbling or solvent action indicates it will work.

Brooklyn, N. Y. L I PINCUS

Depends on Scale

AS A SOLVENT for boiler scale, kerosene may be right or wrong. Much depends on the scale and boiler scales are as different as natural waters. FS should cut and try, by knocking off small pieces and soaking them in kerosene. After a few hours if the pieces crumble, kerosene will clean the boiler. If pieces of scale can't be had, paint or spray a spot and later test its hardness against untreated scale, using any handy tool. A hard scale that kerosene doesn't soften can sometimes be removed this way.

I suggest raising steam in the boiler after kerosene has been added and boiler filled slowly. Boiler mustn't be allowed to foam or kerosene and loose scale may be carried over to the engine. Blow down frequently. If boiler must be forced, kerosene should be removed at skimmer. Due to its effect on cylinder oil, I don't think kerosene should be used regularly.

Marissa, Ill. GEORGE BLUM

May Cause Overheating

FS IS PERFECTLY RIGHT when he questions advisability of using kerosene to remove scale. It often happens, especially where formations cover large areas, that kerosene breaks bond between scale and metal but the deposit fails to break up and stays in place. Scale alone will conduct some heat as long as in intimate contact with metal, but when a space develops between scale and metal, a blanket of steam forms and practically stops heat flow (steam is a good insulator). Local overheating may result.

Roanoke, Va. S H COLEMAN

Too Great a Hazard

I THINK HAZARD bars use of kerosene. With thick scale, an oil-vapor film might form and cause local hot spots with accompanying dangers. Inhibited acids will remove inaccessible scale without harm to metal, but if scale is thick, treatment might prove costly and time-consuming. If boilers now get correctly softened water and no new scale forms, old scale will become "rotten" in time and break up of its own accord.

I would suggest carrying higher alkalinities and greater concentrations and keeping as close to zero hardness as possible. Higher causticity of water will accelerate scale break up.

Newark, Ohio H A DIETRICH

Defrosting Coils

Answers to July Question 2

The Question

IN OUR *storage room we have two sets of direct-expansion ammonia coils. How can we arrange to defrost these coils by using hot gas?*—BES

Use Transfer Header

NEVER ALLOW COILS to become heavily coated with ice because it brings down suction pressure and lowers machine capacity. Best way to defrost is with hot-gas line from discharge side of compressor connected to each of coils, near the top. Transfer header on the bottom permits forcing liquid formed in one coil, during defrosting, into another coil for evaporation. If transfer header isn't used, then hot gas will have to enter coil at feed end and the suction will have to be cracked while gas is being forced into coil. This way takes more time, and use of transfer header is recommended.

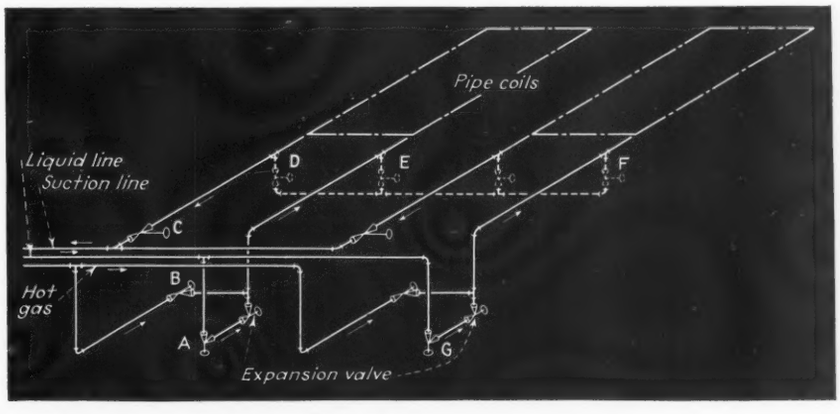
Hamilton, Ontario I S ELLIOTT

Connect Hot-Gas Line Ahead of Expansion Valve

HOT GAS CAN BE USED for defrosting coils by making connections as shown. Shutoff valves in liquid line between receiver and expansion valve are not absolutely needed, but with them, operator can defrost without disturbing setting of expansion valve.

Procedure: Close valve *A* (or expansion valve if *A* not installed). Open *B* slowly to prevent slug of liquid going into coil and then into suction. Then throttle valve *C* to allow pressure to build up in coil and yet pass condensed hot gas to suction line. After defrosting, close *B* and open *A*. Also open *C*, but slowly.

Additional connections shown make it



possible to put liquid refrigerant through an active coil before going into suction line. Defrosting cycle then becomes: Close *A* and *G*, open *B*, close *C*, *E* and throttle valve *D*, and open *F*. When coil is defrosted, close *B*, open *C*, *A*, and *G*, close *D* and *F*.

Waynesboro, Pa. H REICHENBACH

They Agree

L E CANTRALL, Springfield, Ill., uses a similar hookup in his brewery plant and finds it defrosts coils in 10–15 min. A somewhat similar arrangement does the job for J P CAREY, Brooklyn, N. Y., who says it used to take 3 men 8 hours to chip ice from one coil; now one man does it in little or no time. He also suggests welding an outlet to the compressor discharge line if no spare exists.

J E LEWIS, St Thomas, Ont., reminds BES to pump down good before defrosting and to build pressure up slowly in evaporator (for safety). He encloses a sketch embodying the same general idea as that shown. IRVING WEISS, Jackson Heights, N. Y., proposes a similar hookup using a riser from compressor through rooms of cold storage. Riser bypasses part of hot ammonia before it gets to the condenser. Ammonia then is shunted into intake valve. Ammonia vapor turns to liquid and can flow through the return, as usual. Bypassing shouldn't interfere with regular compressor operation.

S G PATERSON, Hamilton, Ont., says defrosting with hot gas is cheapest and safest, and, that by this system, a 1400-ft coil can be defrosted in about 15 min. It needs approximately 70,000 Btu to defrost such a coil. It is not necessary to raise pressure in evaporator coil above 60 lb. There should be plenty of gas right up to the coil and the gas inlet for a 1400 ft coil should not be less than 1¼ in. Mr Paterson goes on to say that main idea is to get frost off as quickly as possible to avoid drips from coils. In case coil is fed from top, it will be necessary to throttle ammonia out.

CHARLES QUINTAVELL, Hawthorne, N. J., suggests that for quick defrosting, using a hookup like that shown, BES should close shutoff valves on suction side of coils or shutoff valve at accumulator. Allowing head pressure to build up in coils gives about 95-F gas temperature, plenty for fast defrosting.

Use Bypass Valves

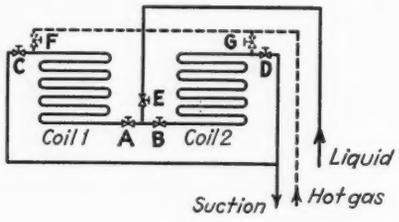
WHEN ICE on evaporating coils becomes too thick, it can be loosened by reversing flow of ammonia so that evaporator becomes a condenser. To do this empty oil separator, and while machine is shut down, close liquid valve between condenser and receiver, close suction and discharge valves, and open crossover bypass valves.

Now start up machine; direction of ammonia flow will be reversed. While pumping back from condenser, care should be taken that cooling water is turned on full or completely shut off and condenser drained, or water may freeze. Watch out for excessive pressure in the evaporator coils.

Hamilton, Ontario TED CLAMP

Connect Hot-Gas Line In Suction Side

SKETCH SHOWS two sets of coils with probable connections and valves needed for normal operation. Dash line indicates hot-gas connections. It is desirable to feed coils upward (flooded), but during defrosting cycle, feed should be downward (dry), permitting refrigerant to flow by gravity toward expansion valves, and keeping coil



free from accumulation of liquid. This arrangement also keeps entire coil in contact with hot gas, which is important for uniform defrosting.

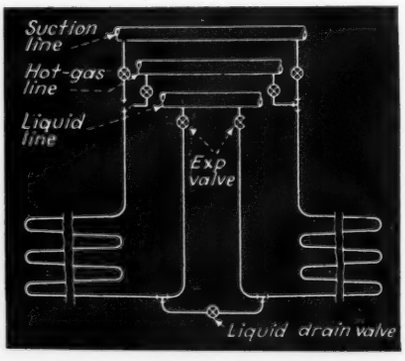
Cycle for defrosting Coil 1: Close valves *E* and *C*, and open valve *F*. Valves *A* and *B* remain set for expansion of liquid and need only minor adjustment to regulate flow of liquid formed in Coil 1 into Coil 2, where it evaporates. With this arrangement, one coil serves as condenser (defrosting) and the other does useful work as evaporator. During defrosting, valve *G* stays closed and valve *D* open. To defrost Coil 2, close *F* and *D* and open *C* and *G*. Valve *E* stays closed and *A* and *B* only need adjustment to regulate liquid flow.

St Louis, Mo. H J KIPP

Different Hookup

WHETHER COIL is arranged for top or bottom feed, the hot-gas line should be connected to coil at its highest point and liquid should drain to lowest point.

Sketch shows two coils with both suction and liquid headers located above, connected for defrosting. To defrost either, close suc-



tion valve and open hot-gas valve; close expansion valves on both coils. Adjust liquid valve as an expansion valve so there is liquid seal above valve preventing gas blowing through to evaporating coil. Liquid condensed in coil being defrosted will be evaporated in other coil and thus serve a useful purpose.

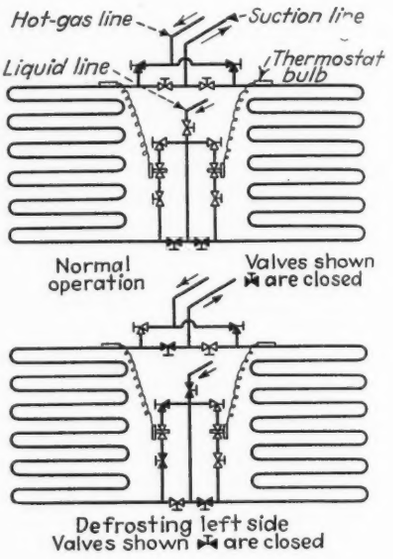
Rochester, N.Y. JULIUS BRODSKY

Further Notes

ROBERT ELLIOTT, Calexico, Calif., uses a hookup somewhat like H J Kipp's, but he has an ice tank and finds draining the liquid formed in the defrosting coil quickest and easiest way of handling it. As an alternative, he can expand liquid in another coil, as Kipp suggests. C L WHITAKER, Waynesboro, Pa., has used method shown in the sketch for years and finds it most satisfactory of all. It works fast, and by permitting normal coil operation, it doesn't cause much change in refrigerated-room temperature.

Controlled Defrosting

SYSTEM SHOWN in the sketch is safe, with practically no chance of slopping back to the compressor. It suits storage rooms where thermostatic valves (with sensitive bulb attached to or inserted in suction line) regu-



late flow to coils. In defrosting by this method, amount of liquefied hot gas passing through thermo-expansion valve is regulated by bulb temperature.

San Francisco, Calif. R WOLF

Use Pumpout Line

BES HAS AN EASY JOB if there is a pumpout line to coils. A connection from compressor discharge to pumpout line, with a valve, is all pipe fitting necessary, except for installation of gage able to indicate pressure at least as high as discharge gage.

To operate, close king valve to storage rooms, close suction valve on coil to be defrosted, open pumpout valve for coil to be defrosted, and open expansion valve wide. Open hot-gas valve carefully, allowing just enough pressure to do defrosting and not exceeding safe limits for pipe. Keep close watch on hot-gas gage as pressure will rise as defrosting continues. Liquid ammonia will flow through wide-open expansion valve and can be expanded through a second set of coils, providing that each has its own expansion valve and that coils are shut off from receiver by king valve.

Brooklyn, N. Y. F H FOLEY

ARGUMENT CORNER

More Men Go to School

I WAS MUCH INTERESTED in reading the article, "Power Men Go to School", July POWER. We have been conducting a school here for years as part of the vocational training system of the public schools, giving the janitors and engineers a 3-year training course.

It is compulsory for all janitors and engineers to come to school 2 hours a week for the first 3 years of their service during the public-school year. They come on the school board's time.

As far as I know, this school is the only one of its kind in the world, which takes in a great deal of territory. It has been operated for years and has been found a very paying venture.

Articles in POWER relating to our work are discussed fully every month.

Minneapolis, Minn. O A ANDERSON
Minneapolis Public Schools

Cooperation is the Answer

FOR SOME TIME I have read contributions in various engineering periodicals about college- and non-college-trained engineers. It would seem that better cooperation instead of suspicion is the proper solution.

Even in the best-equipped and best-run power plants (in a large number of cases superintended by college-trained engineers), the brass hat is entirely dependent for actual operation of equipment upon men who have gotten their knowledge through practical experience, coupled usually with correspondence or night study.

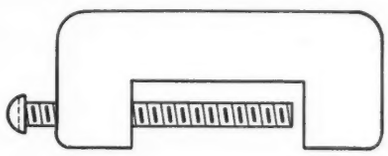
When the head of the power department and the men under him have mutual respect for each other's knowledge and abilities, then real cooperation appears and results can be achieved never possible under the present suspicions of encroachment on each other's fields.

In practically all power plants there will be some young men starting at the bottom, usually without too much technical training, who have the inherent abilities necessary to become superintending engineers. If the head of the power plant, be he college or non-college trained, does not impart his technical knowledge to the best of his ability to these men as they come up from the ranks so that they may assume equal or better positions eventually, then it is my opinion that he is a failure as an engineer, even though he may have a string of degrees a mile long.

Worcester, Mass. F H VAN DYCK

Handy Wooden Clamp

THE STEEL YOKE and bar clamps shown on page 104, June POWER, are very handy, but I have made substantial *C* clamps from ¾-in. plywood, as in the figure. The wood is cut to the proper shape and is then drilled and tapped for a ¼-in. screw. Of course, care must be taken when drilling and tapping the



wood not to overstress it. The clamps are light weight and will stand far more wear and strain than seems possible for wood.

Coffeyville, Kan. EARL PAGETT

Short-Center Belts Also Sweet Running

THE ARTICLE, "Sweet-Running Belts," in the Operating Engineer, June POWER, showed a photograph of two long-center belt drives. This type makes it easy for the power-application engineer and the belt and pulley manufacturers, but in many cases, there is no room for long-center drives.

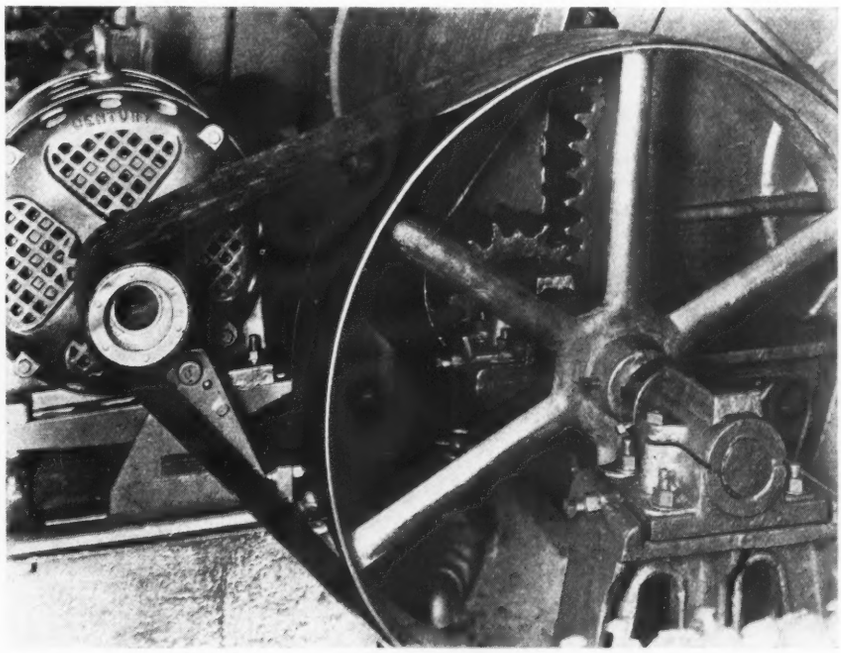
However, short-center belts have been developed to the point where they are equally satisfactory. When properly designed, they can be applied to just as difficult drives, as the photo shows.

This drive is on a tumbling barrel in a foundry and must handle the high-inertia starting load of the loaded barrel and also the pulsating shock load of material working up the side of the barrel and tumbling back.

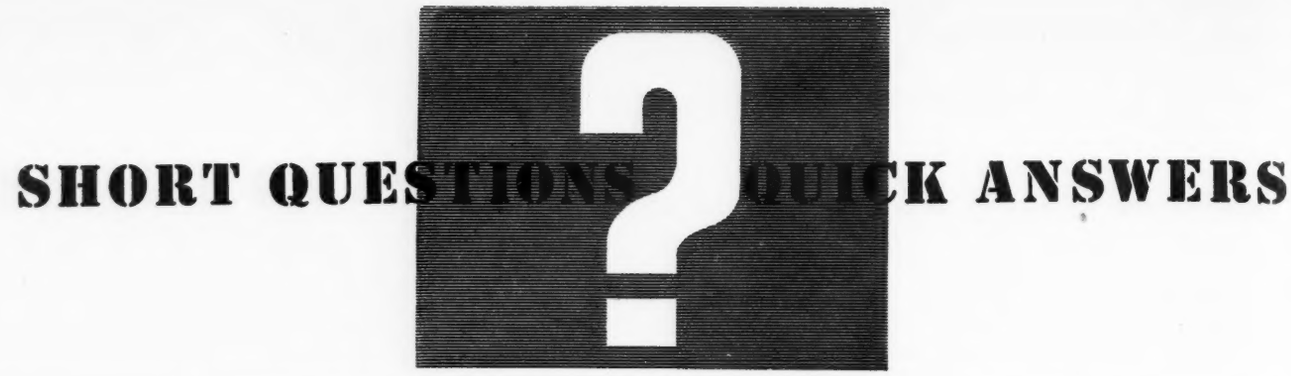
A 30-hp, 865-rpm motor mounted on a reaction-torque base automatically keeps belt tension proportional to load transmitted. The motor pulley is 7-in. and the driven pulley 51-in. diameter, a pulley ratio of 7.3 to 1. Pulleys operate in a 42-in. center distance and because of this, the belt, which is 12 in. wide, makes an arc of only 118 deg on the motor pulley.

Such a short center distance and large pulley ratio are not recommended where more favorable conditions prevail. But where it is necessary, even worse conditions than those shown in the photo can be satisfactorily powered with well-designed, short-center, flat-belt drives.

Philadelphia, Pa. ROBERT SHARP
The American Pulley Co



Short-center, flat-belt drive performs under tough conditions



More About Watertube Boilers

by Harry Spring

Q—Is the volumetric capacity provided in each gas pass the same? Why?

A—No. It decreases in each succeeding pass because the gas contracts as it cools. In order to maintain high gas velocity to sweep stagnant gas films from the tubes and effect good heat transfer, the cross-sectional area of the passes must decrease as the gas requires less space.

Q—What are the two most important things in the support of a boiler?

A—(1) To allow free expansion of all parts, and, (2) To support total weight with a reasonable factor of safety so that there will be no settling to stress any part.

Q—Where does the feedwater enter and where does it discharge in a B&W longitudinal-drum boiler, and in a Heine boiler?

A.—It enters through the front head of the B&W and discharges to the rear of the front cross-box. It enters through the top of the drum and discharges into the front of the internal mud-drum in the Heine. Feedwater should not discharge against a riveted seam or directly against the drum in any type of boiler.

Q—What watertube boilers use staybolts?

A—Box-header boilers.

Q—How are staybolts used in connection with blowing soot from tubes?

A—In the Heine boiler the staybolts are hollow. The holes are of sufficient size to permit a steam or air lance to enter through the staybolts for blowing soot.

Q—What is a downcomer nipple?

A—It is a short length of boiler tube between steam drum and rear header to permit downward circulation of boiler water.

Q—What type of cross-drum boiler has inclined downcomer nipples? Why?

A—Standard Springfield boiler, because the steam drum is located forward of the rear headers.

Q—Where are inter-deck nipples used?

A—In double-deck boilers where two sets of headers are connected one above the other.

Q—Name the two main sheets of a box-header.

A—The tube sheet and the hand-hole (or tube-cap) sheet.

Q—What is the narrow plate forming the bottom of a box header called?

A—The header trough.

Q—How many courses are in a cross-drum boiler drum? Why not more?

A—One, because a girth seam would interfere with the tube ligament, and because it is not necessary.

Q—Is it more difficult to withdraw a tube from a watertube boiler than from a firetube boiler? Why?

A—It is usually more difficult with the firetube because any scale formed by the water will be on the outside of the tube which has to be drawn through the tube hole.

Q—How many blow-down connections would you expect to see on a triple-drum longitudinal B&W boiler, and where would they be?

A—Not less than two, possibly three, installed equidistant along the bottom of the external mud-drum.

Q—How many blowdown connections would you expect to see on a single-drum, standard Heine boiler, and where would they be?

A—Not less than two. One through the rear head from the internal mud-drum, and at least one at the bottom of the rear box header.

Q—How many gaskets are required for tube caps (hand-hole plates) covering ends of eight tubes in a standard Springfield boiler?

A—Four.

Q—What type of straight-tube watertube boiler uses the least floor space per unit of capacity up to about 200 lb per sq in. pressure?

A—The vertical type.

Q—What type of furnace is required with the vertical watertube boiler?

A—Dutch oven.

Q—What is the general rule for feedwater discharge, not only in watertube boilers, but in all types of steam-generating units?

A—It should not discharge in close proximity to riveted or welded seams, nor against plates exposed to high-temperature gases.

Q—If the area immediately surrounding a staybolt is badly corroded, what should be done?

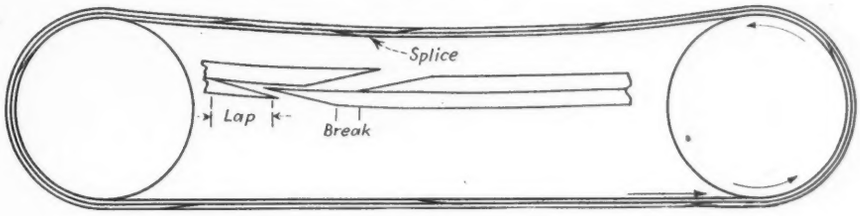
A—Remove the staybolt, ream and tap the hole, and install a large-size staybolt. Needless to say, the threads of this staybolt should contact solid metal.

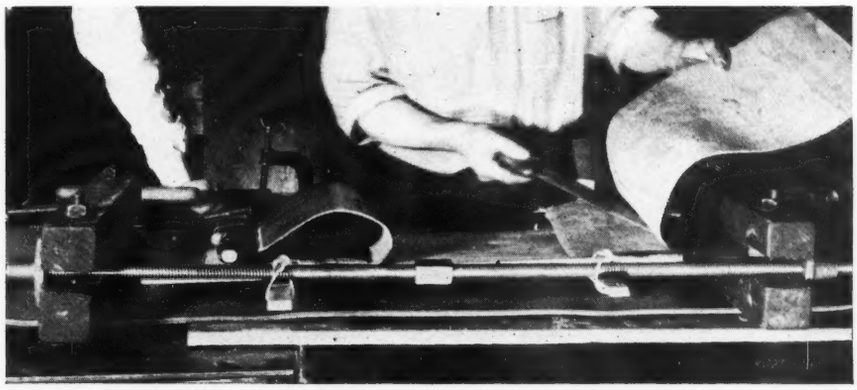
HOW TO SPLICE TWO-PLY LEATHER BELTS

Standard instructions for "factory lap", made with belt in running position on pulleys. Photos posed by POWER in New York plant of Chas A Schieren Co

1 →

Set up for laps as shown. Be sure belt runs so that inside laps *trail*, also that existing laps in belt run same way. Follow (approximately) lap dimensions given in table





← **2**

Set clamps about 6 in. outside section to be worked on. Set belt ends central in clamps, exactly squared and in line (very important). Take up on rods until belt is slightly tighter than for running (to allow for slack between clamps). For a "work table," tie a heavy board beneath belt, snug against clamps

TOOLS NEEDED

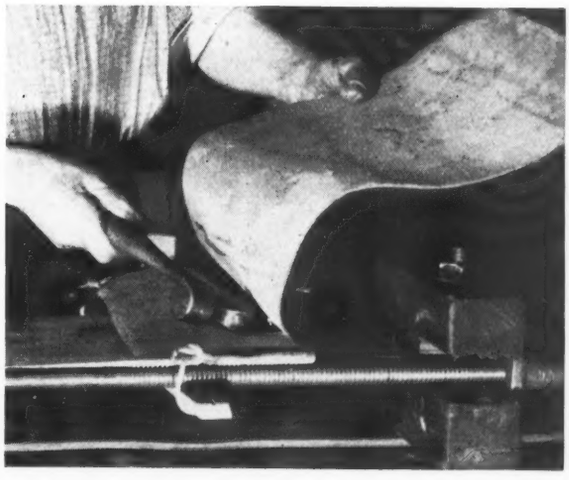
1. ***Belt clamps and rods (can be home made)***
2. ***Scraper***
3. ***Finger steel to sharpen and clean scraper edge***
4. ***Turning steel for "hooking" scraper edge***
5. ***Sharp knife***
6. ***Dull "bayonet" knife***
7. ***Straight-pein hammer***
8. ***Square***
9. ***Belt plane (or ordinary block plane)***
10. ***Waterproof liquid belting glue***
11. ***Round glue brush***

DIRECTION AND SIZE OF LAPS, INCHES

Belt width	*Laps*	*Break*	*All over*
1 to 12	4	4	12
12 to 20	4	10	18
20 and over	4	16	24

3 →

Separate belt plys with straight-pein hammer, or with stabbing strokes of edgeless bayonet knife (as in Fig. 2). Cut ends square to fit exactly

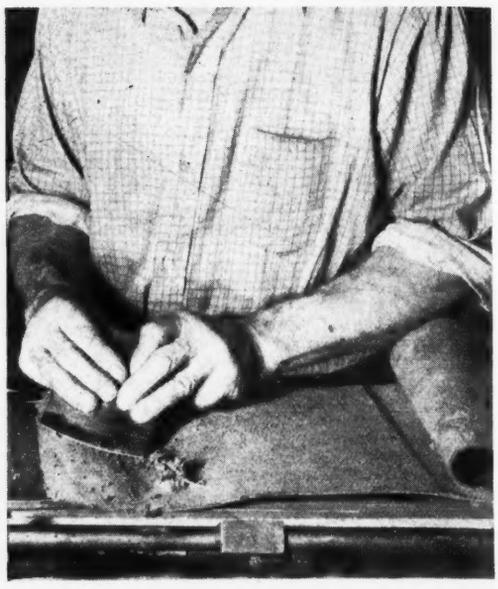


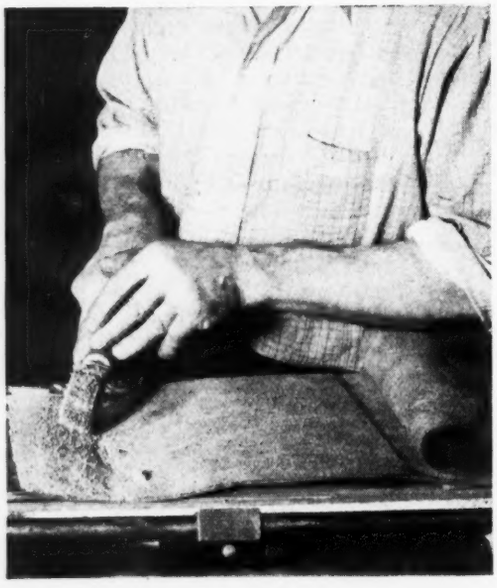
←4

Plane edges or scarfs to true bevel. Use a knife to finish to feather edge if necessary

5→

Finish surface flat and true with sharp scraper





←6

Then roughen with wire wheel to help glue stick. Lay laps together to check perfect fitting and make sure there are no thick or thin spots

7→

Size surface with belt glue and allow 30 min. to dry. Up to 4-in. belt, glue in one step; from 5-in. to 18-in. in two steps; wider in three steps

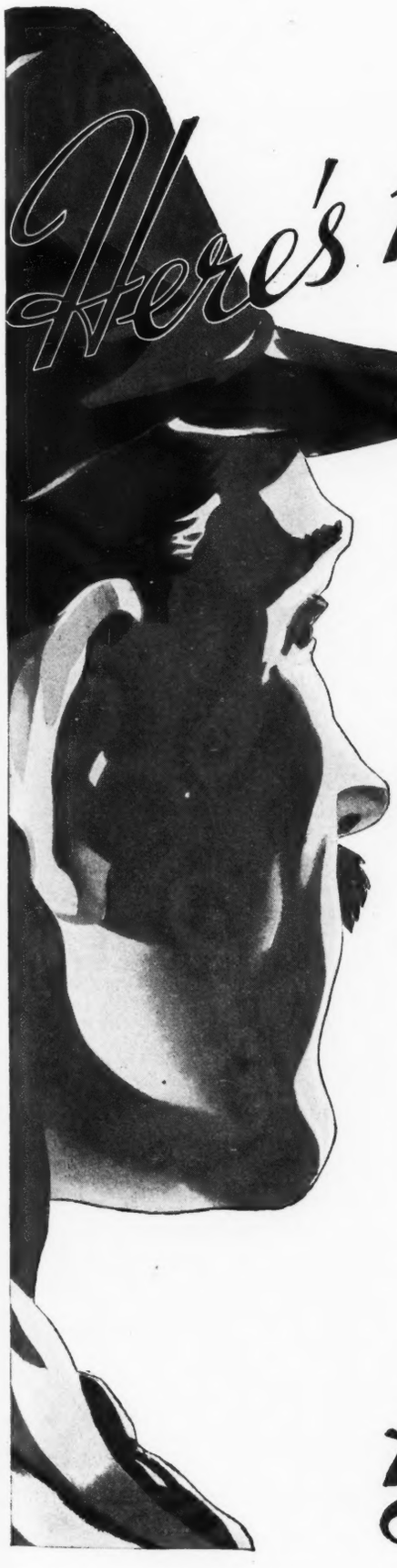
←8

Apply sticking coat and bring surfaces together at once. Press and rub with wood block or rubbing stone

9→

Then grip tight between heavy boards, using four or more clamps. Take off boards after 30 min. With belts larger than 4 in., requiring gluing in two or more steps, do same for each step. Then let whole job dry for 2 to 8 hours

"PYREX" BROAD RED LINE GAUGE GLASS



Here's how you see it

ONE glance at a "PYREX" Broad Red Line Gauge Glass is sufficient to reveal water level. The broader, transparent red line, fused permanently into the wall of the gauge glass itself, permits illumination by transmitted *or* reflected light, with increased visibility from every angle and from greater distances. If you can see the gauge glass you can read the water level.

Because of this greater visibility there is an added margin of safety. Because of its machine drawn accuracy, resistance to heat and cold, chemical stability and permanence of visibility there is the added assurance of the economy and performance that have always been associated with all "PYREX" Gauge Glasses. Write today for complete literature.

Stocked by Leading Mill and Steam Supply Dealers

Pyrex BRAND GAUGE GLASSES

CORNING GLASS WORKS, CORNING, N.Y.

"PYREX" is a registered trade mark and indicates manufacture by Corning Glass Works.

Engineers' Bookshelf

POWER VETERANS

The camera caught an interesting shot in the office of N O Wynkoop, POWER's publisher, when Mrs Emerson P Harris, widow of the founder of POWER, visited New York to see the World's Fair. She is pictured with Chester Dibble, oldest member of the POWER staff. He has been with the magazine since 1887, three years after it was founded

Exhaust Systems

DESIGN OF INDUSTRIAL EXHAUST SYSTEMS (1939). *By John L Alden. Published by The Industrial Press, 148 Lafayette St, New York, N. Y. 220 pages, 5½x8½ in., 110 illustrations, cloth binding. Price $3.00.*

This book fills a long-felt gap in the literature and will be welcomed by all industrial power engineers likely to face the problems of designing or buying an exhaust system. The presentation is practical throughout, but since air flow is the basis for the entire operation, the author properly begins with a condensed but up-to-date discussion of flow of fluids. This leads naturally to the more specific subjects of hood forms, flow of air through hoods, pipe resistance and piping design, dust separators, centrifugal exhaust fans, structural details and field measurements.

The chapter on low-pressure conveyor systems should be of particular value to engineers in plants where waste fuels such as sawdust, rice hulls, etc, have to be moved from source to boiler house.

Machine Design

MACHINE DESIGN (1st Edition—1939). *By Stanton E Winston, Associate Professor of Mechanical Engineering, Armour Institute of Technology. Published by American Technical Society, Drexel Ave at 58th St, Chicago, Ill. 333 pages, 5½x 8½ in., 145 illustrations, 26 tables, cloth binding. Price $3.00.*

Power engineers have a very intimate interest in machine design. For example, to connect a motor to a machine, a coupling, belt and pulleys, chain and sprockets, gears or other mechanical power-transmission equipment must be selected. The success of the drive depends upon the engineer's ability to correctly estimate the size and capacity of this equipment. The solution of difficult lubrication problems frequently depends upon the power engineer's knowledge of bearing design. Again he may be called upon to estimate the stresses in pressure vessels or the loading on beams, all of which is part of machine design.

This book is well suited to engineers who have to deal with such problems. It is divided into 9 chapters: fundamental principles—simple stresses; fundamental principles—compound stresses; bolts and screws; cylinders and riveted joints; shafting and keys; couplings and clutches; flat belts, multiple V-belts, chains, pulleys, sheaves and sprockets; friction drives, spur and beveled gears; and miscellaneous details of design. Presentation of the subjects is practical—calculus has been eliminated. Any one with a practical working knowledge of algebra and trigonometry will have no difficulty in using any part of the text. Many problems are worked out to show applications.

Tools

TOOL MAKING (1939). *By C B Cole, Consulting Mechanical Engineer. Published by American Technical Society, Drexel Ave at 58th St, Chicago, Ill. 413 pages, 475 illustrations, cloth binding. Price $3.50.*

Every engineer has to use tools and many, at various times, have to make them. This book, although written for the toolmaker, contains much that will be helpful to every operating engineer. The first part of the work is devoted to the use of tools and gages such as scales and punches, scribers, steel squares, calipers, micrometers, straightedges, hardness-test devices, steel beam trammels, Johansson gage blocks, drills and reamers, countersinks.

The latter part of the book covers use of common types of machine tools, hardening processes, nitriding, cyaniding, jigs, dies, fixtures and many other things that engineers have to know about. The text is so written that the beginner is led from the simple facts about his personal tools and shop equipment to the processes of the toolmakers craft, by the presentation of many typical jobs.

Coal

HOW TO BUY, SELL AND BURN COAL (1939). *Written and published by Thomas A Marsh, 5625 Kenwood Ave, Chicago, Ill. 97 pages, 5x7 in., stiff paper binding. Price $1.00 (quantity prices, including U. S. postage, 90 cents each for 10 to 24 copies, 80 cents each for 25 or more copies).*

The value of this book should not be judged by its size. Small in physical dimensions, it contains the combustion facts of greatest interest to those immediately concerned with selection and burning of coal.

Mr Marsh is an authority on fuels, furnaces, stokers and combustion. He has had broad experience in testing, operating and designing practically all types of fuel-burning equipment from central station to small domestic units. He is particularly familiar with stoker problems. The book reflects this practical experience. It is definitely practical in every way, and free from any mathematics beyond simple arithmetic.

Chapter subjects include Selection of Coal for Manufacturing Plants and Commercial Heating Plants; How to Cut Fuel Bills; How to Stop Smoke; How to Increase Efficiency; How to Increase Steam Output and How to Read Fires.

Of particular value is the elaborate schematic analysis of trouble effects and causes with remedies for scores of fuel-burning difficulties. This trouble-shooting section will be appreciated by practical men.

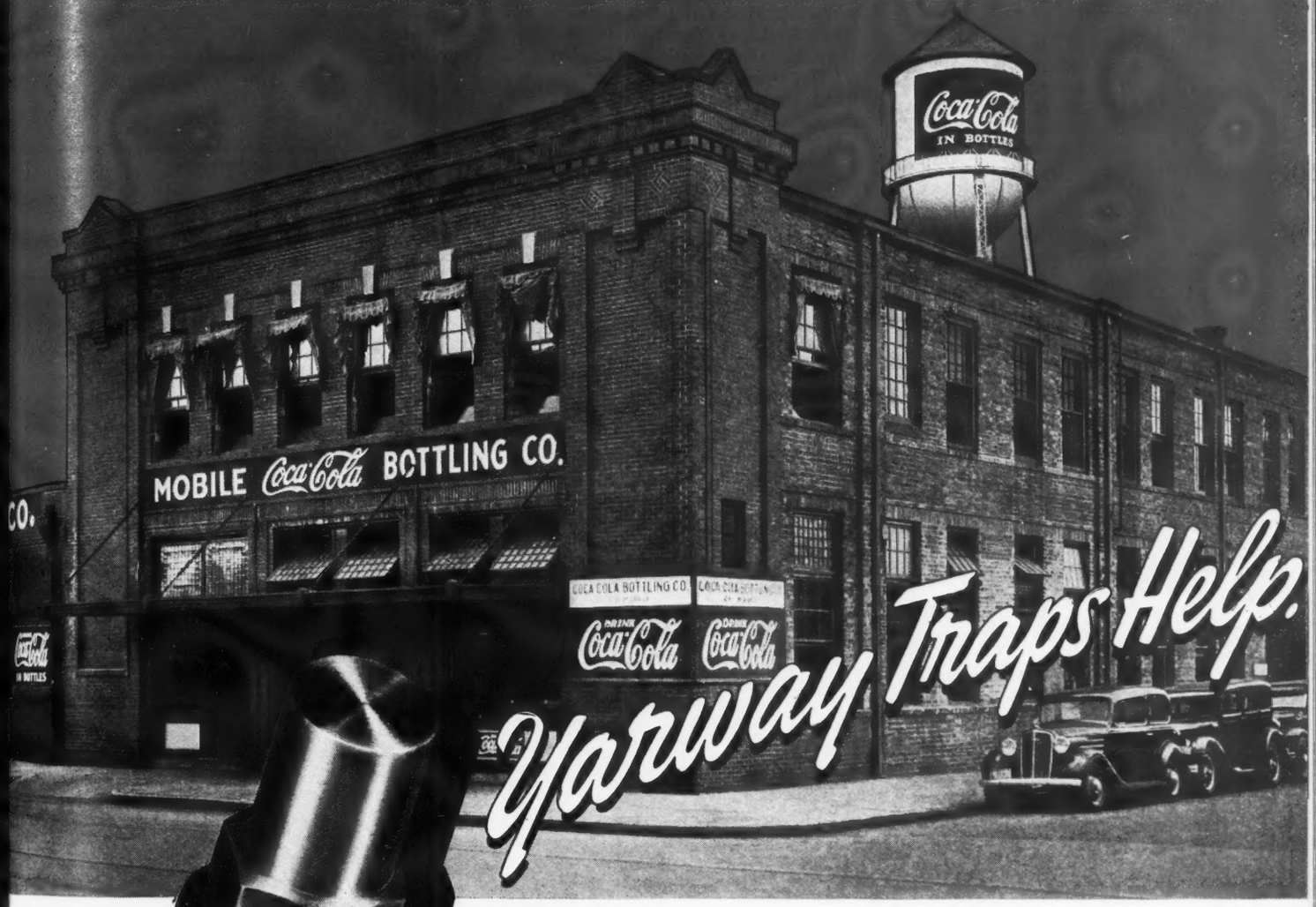
Illumination

PRACTICAL ELECTRIC ILLUMINATION AND SIGNAL-WIRING METHODS (3rd Edition—1939). *By Terrell Croft. Revised by George H Hall. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York, N. Y. 351 pages, 5½x8 in.; 293 illustrations; tables. Price $3.00.*

Many improvements have been made in the field of illumination methods and their applications during the last ten years. This is particularly true in the design and efficiency of incandescent lamps; so much so that use of arc lamps for general illumination is being discontinued. The revision has been made to make this book conform with these changed conditions.

(Continued on page 142)

Refreshing the Bottles That Refresh the Nation



On bottle washers, unit heaters and fuel oil tank heaters—"Yarway Impulse Steam Traps are giving excellent service" at the Coca-Cola Bottling Co., Mobile, Ala., reports Mr. Walter K. Smith.

Yarway performance talks. Their quicker heating and greater sustained heating efficiency soon pay for their installation and continue to return worthwhile profits in plant operating economy. And when you consider that their purchase price is usually no more than the cost of repairing an ordinary trap—why not get Yarway performance for your money?

Install a Yarway Impulse Trap or two and let them demonstrate what they can do for you in speeding production and saving fuel. See how its small size saves space. How its light weight simplifies installation. How its unique design with only one moving part, and its rugged bar-stock construction, practically eliminate maintenance expense. Then too, Yarway Traps are suitable for all pressures without change of valve or seat.

More than 50,000 Yarway Traps have been installed. A nearby Mill Supply Dealer handles them and will be glad to serve you. Or write for Catalog T-1734.

YARNALL-WARING CO., 100 Mermaid Ave., Phila.

YARWAY IMPULSE STEAM TRAP

Power Lines

Groups Celebrate Centennial Of R H Thurston's Birth

The centennial of the birth of Robert Henry Thurston, pioneer in engineering education and first president of the American Society of Mechanical Engineers, will be celebrated on October 25 at Ithaca, N. Y., by Cornell University in connection with the A S M E. Delegates from American and Canadian engineering schools, technical and academic societies in this country and abroad in which Dr Thurston was a member, together with the alumni of Stevens Institute of Technology and Cornell University, will be special guests.

Celebration will be a 1-day affair, including an academic procession, and convocation in the morning, an exhibit of Thurston's publications and of laboratory apparatus he designed, and other events.

Industrial Advertisers Meet

A 3-day session, and 16 clinics answering more than 200 questions, will be the features of the 17th Annual Conference and Exposition of the National Industrial Advertisers Assn when it meets at the Hotel New Yorker, New York, Sept 20–23.

Starting with the registration the first day of the conference, the meeting will move forward under the direction of discussion leaders, advertising men from numerous companies. These include Ted Marvin, Hercules Powder Co; Terry Mitchell, Frick Co; J L Rosenmiller, York Ice Machinery Corp; J M McKibben, Westinghouse Electric & Mfg Co; Louis J Ott, Ohio Brass Co; Guy Bartlett, General Electric Co; and many others.

The business session and election of 1939–40 officers will take place Friday afternoon, Sept 22. Stan Knisely, Republic Steel Corp, is president at the present time.

Simonds Saw & Steel Opens Windowless Plant

Simonds Saw & Steel Co, Fitchburg, Mass., has opened the first windowless factory, which is completely air conditioned and acoustically treated. The 5-acre, single-room structure was built in 1931 by the Austin Co, and was conditioned and equipped for production.

Operating two 8-hr shifts, 5 days per week, the plant provides each employee uniform light through more than 1400 100-watt fluorescent tubes, which produce an illumination level of 20 to 25 ft-candles, with a minimum of shadows. An elaborate air conditioning system keeps the atmosphere clean and comfortable despite 70 heat-treating furnaces and over 1000 grinders, cutters, and other machines, which are operated almost continuously. Walls are of acoustic block and the cork-filled ceiling is designed to absorb most of the sound, and muffle noises created by the machines. Large drop hammers and other heavy machinery are specially isolated on foundations with shock-absorbing insulation.

About 17,000 lineal ft of underfloor power ducts takes care of the 6000-hp electrical load. Over 38,000 ft of piping, 60,000 ft of conduit and 3½ mi of wire have been installed to serve all electrical controls.

Buzzard Point Extension

Construction of the 50,000-kw extension to the Buzzard Point of the Potomac Electric Power Co, in Washington, has just been started by Stone & Webster Engrg Corp, who designed and constructed the original installation at this plant. The work will include an extension to the present power station building to house the new turbine-generating unit with its auxiliaries, the electrical switching apparatus, and a boiler installation having a capacity of 525,000 lb per hr. When the plant is completed in 1940, the plant will have an installed capacity of 120,000 kw.

Start Capitol Steam Tunnel

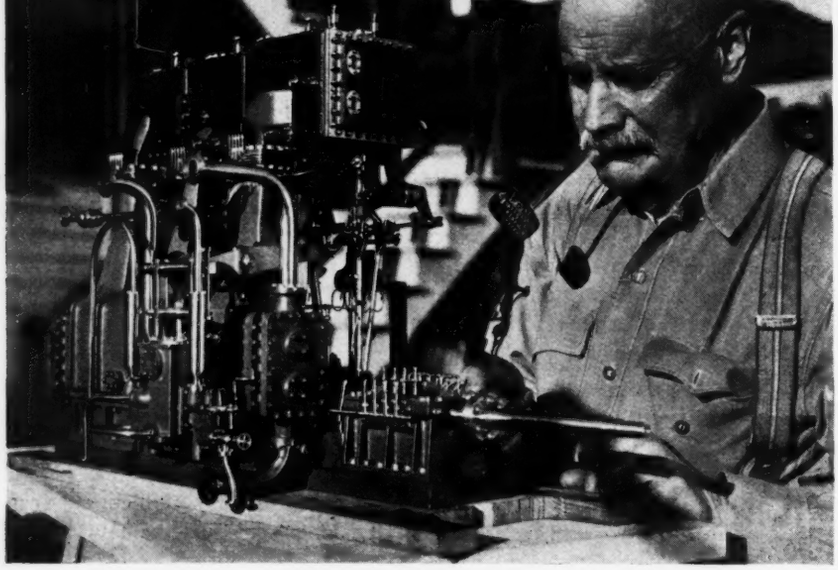
Construction of a steam tunnel, estimated to cost $85,000, for heating a new administrative building, one of a group to be erected in what is known as the Municipal Center in Washington, D. C., has been announced. The building which will be fed by the tunnel is now under construction, and will require 3500 lbs of steam per hr. The tunnel, which will be a branch of the main tunnel, leading from the central heating plant, will contain a steam pipe large enough to supply the district development, in addition to the HOLC building, which is now fed through the conduit. The central-heating plant furnishes steam for downtown government buildings. A separate plant supplies buildings on Capitol Hill.

Coal Utilization Topic of ASME Joint Meeting

Coal utilization is to be the central topic of the 3rd Annual joint meeting of the Fuels Div, American Society of Mechanical Engineers, and the Coal Div, American Institute of Mining and Metallurgical Engineers, to be held at the Deschler-Wallick Hotel, Columbus, Ohio, October 5, 6, and 7.

The program committee, composed of H O Croft, State University of Iowa; H F Hebley, Commercial Testing and Engineering Co; H E Nold, Ohio State University; J E Tobey, Appalachian Coals, Inc, and R A Sherman, Battelle Memorial Institute, chairman, recently announced the completion of the technical program centering about this general subject.

Other topics planned for the meeting include, "Coordination of Fuel Engineering from Mine to Consumer", "A Pro-



MASTER AND MODEL

Fred Hood, lover of steam engines, craftsman, looks over his handiwork, a triple-expansion marine engine complete and working to the last detail. Editor Phil Swain, who inspected Hood's home workshop in Los Angeles during the recent western trip, reports that Fred is a "gentleman and a mechanic and what higher praise could you give any man." *(See page 72 for report of trip)*

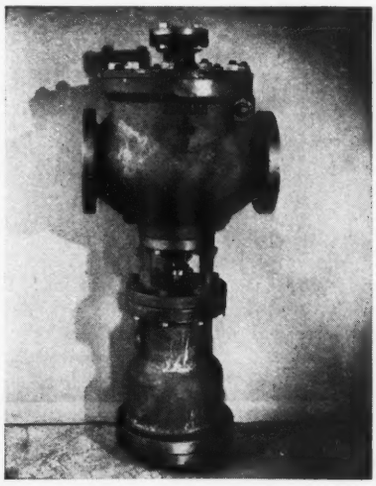
Photo News
Valve values

TITLE REG. U. S. PAT. OFFICE AS TRADE MARK

THE EDWARD VALVE & MFG. CO., INC. • EAST CHICAGO, INDIANA

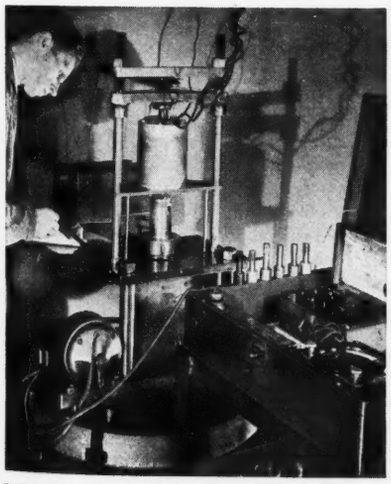
MIGHTY BOILERS SERVED BY EDWARD HAND CONTROL VALVES

SWING TYPE NON-RETURN VALVE FOR EXTRACTION LINES



Here is the newest addition to the Edward series of bleeder line non-return valves. This is size 6 in. Other sizes go up to 24 in. In normal use it operates as a plain swing check valve. The bottom cylinder contains a compressed spring, exerting hundreds of pounds pressure, which in case of emergency is released upon loss of turbine oil line pressure, pulling the swing disk to positive closure. Minor refinements have been incorporated in the latest addition to this line, designated in Edward Catalog 11K as Fig. 212. It protects turbines against back flow through a bleeder line. It is made in steel or iron, according to working conditions.

IT'S NEW !



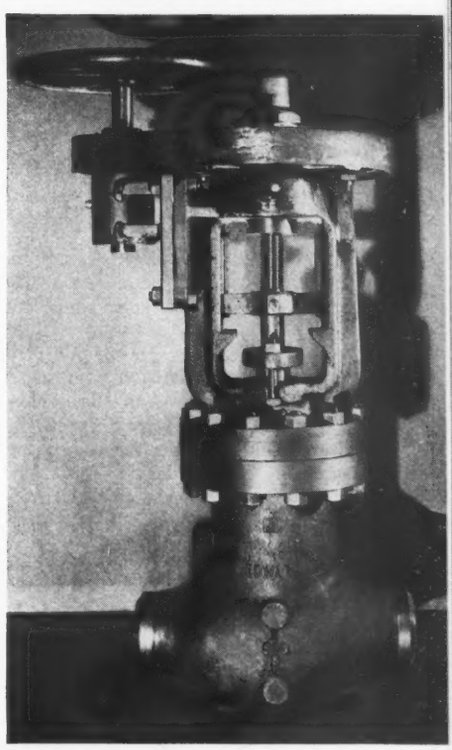
STUDY ABRASION OF HOT STEELS

Edward laboratory workers have studied for years the problems of friction and galling of valve parts. These tests, conducted with the aid of the equipment at the left, subject rings of steel to high temperatures under reciprocating motion. Loads range from 100 lb psi up to 2000 lb. Chemical and physical properties, hardness, machine finish, prior working—cold or hot—are among the variables related to abrasion tendencies. Recent projects seek to isolate effect of high pressure on surfaces in operating contact.

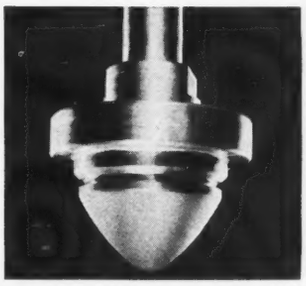
OLD FIG. 2688 DOLLED UP

Perhaps you haven't noticed the rejuvenation of the leader of the Edward forged steel valve lines, Fig. 2688. As the years pass, improvements in material and design have been incorporated without interfering with complete interchangeability of all parts. Conspicuous in this external view of a 2 in. Fig. 2688 are the new streamlined body—with reduction of weight but no impairment of strength or effective wall thickness—the improved packing nut, and the high leverage knobbed handwheel. Over 13,000 sq ft new production space at Edward plant permits simplified and improved quality control.

Increased use of Edward globe valves, with parabolic disks for manual throttling regulation, marks recent installations.



Beginning with feedwater control of an early super-boiler, operating in the 1400 lb range at a steam temperature above 900 F, this type of valve has had occasion to prove its usefulness for water, oil or steam service under widely differing conditions. Shown is a 5 in. 900 lb valve with Stellited disk and seat, built for a southern cotton mill. This bonnet has a pad for possible future installation of motor control. Regulation at present is by handwheel through pinion, gear and EValthrust yoke bushing. Similar valves have been built in various sizes and pressures from 2½ in. to 16 in. and from 200 lb to 1800 lb. In details of construction and internal flow areas they have those characteristics which have been found important in Edward standard globe valves. They demonstrate the rule that it takes a globe valve for throttling service or for tight closure. Your Edward representative has further details.

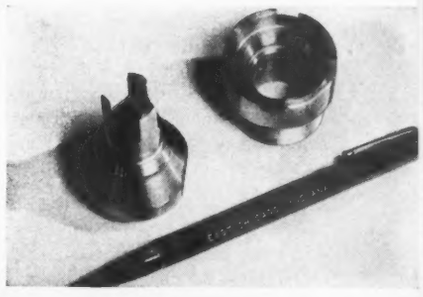


DISK OF PARABOLIC FORM

Here is the type of parabolic disk used in the regulating valve above. Through the most useful range of capacity of the valve, the flow area through the seat is proportional to handwheel movement. Seating is on beveled surfaces which separate before the streamlined parabolic plug exerts effective control.

NOTCHED DISK ALSO USED

For valves of smaller sizes, 2 in. and down, the notched type of triple guided disk shown in the cut has its advantages. The disk lifts well off its seat before full regulation begins through the apertures formed between the seat and the disk guides. The aperture areas vary in proportion to handwheel movement.



EDWARD Valves

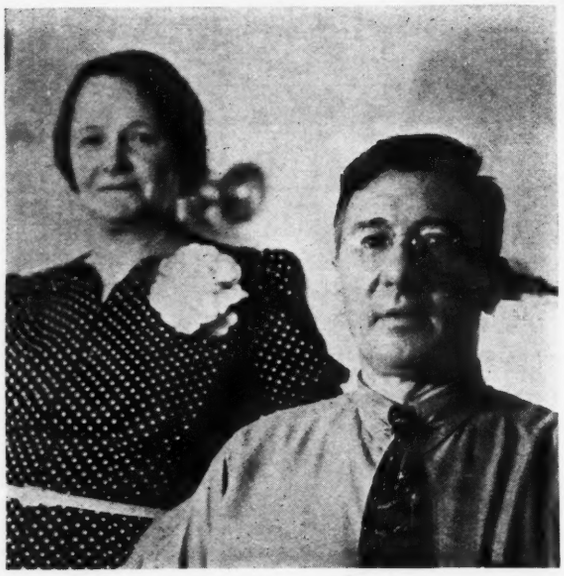
STOP • CHECK • BLOW-OFF • NON-RETURN
FEED-LINE • RELIEF • BLEEDER LINE • ETC.

posed Code for Testing Coal", and "Recent Developments in Equipment for Burning Anthracite Coal".

Unit-Heater Meeting

Skytop, Pa, was the scene of the recent 2-day meeting of the Industrial Unit Heater Assn. This meeting focused attention on the work of the Association, discussing the standardization of piping and motors. A fact brought out during the meeting was that 93% of all unit heaters sold are manufactured by members of the Industrial Unit Heater Assn, and that by this cooperation it was possible to improve greatly the unit-heater field, and reduce expensive selling. L O Monroe is secretary of the Industrial Unit Heater Assn.

THE KAPPELHOFFS OF L.A.



J C Kappelhoff and wife snapped in power-plant office of Hotel Clark, Los Angeles. Chief "J C" has just completed a tunnel carrying steam mains under street from boilers in the Subway Terminal Bldg to engines in the hotel

OBITUARIES

ARNOLD E WEICHERT, 64, with Combustion Engineering Co, Inc, New York, for 24 years, died at his home in Bloomfield, N. J., July 2. He was born in Staten Island, N. Y., and received his early education in New York public schools and in Germany. After studying for two years at City College of New York, he entered Stevens Institute of Technology and was graduated with a degree of M E in 1897. He had been a member of the A S M E since 1907.

BENJAMIN F GARRY, 58, an engineer on staff of Danvers, Mass., State Hospital for the Insane, died in Salem, Mass., July 20, after a brief illness. He was born in Nova Scotia.

WILFRED R WOOD, 69, member of the executive committee and consultant to the president of Combustion Engineering Co, Inc, New York, died at Doctors Hospital, New York, N. Y., July 14. Mr Wood was born in Virginia and obtained some early engineering experience with Fishkill Landing Machine Works and Russell & Co, Massillon, Ohio. While there he designed one of the first road rollers made in America, which was exhibited at the World's Fair in Chicago, 1893. Shortly after that he became identified with the design and development of underfeed stokers, first with Stoddard Mfg Co, and later as chief engineer of The American Stoker Co. While on a 30-year stay in England, he formed the Underfeed Stoker Co, and designed one of the first self-cleaning underfeed stokers. He was also instrumental in developing the plate-type air preheater. He returned to the United States in 1929 and was identified with Combustion until his death. Mr Wood held 38 U. S. patents and more than 100 foreign patents dealing with stokers, steam generators, pulverized-coal- and ash-disposal equipment, superheaters and controls, and air preheaters.

ARTHUR H ABBOTT, 56, formerly transformer specialist of Boston office, General Electric Co, died at Winchester, Mass., July 31. He was well known as a manufacturers' representative in New England.

FRANK S CLEGHORN, 72, head of Cleghorn Engineering Co, Boston, Mass., died suddenly at his summer home in Marblehead, July 31. He founded the company 40 years ago, and was widely known in power engineering circles. He was born in Adams, Mass.

PERSONALS

CLYDE L SEAVEY, of California, and CLAUDE L DRAPER, of Wyoming, have been elected chairman and vice chairman, respectively, of the Federal Power Commission. Chairman Seavey was appointed to the commission August 13, 1934, following a term with the California Railroad Commission. Previous to that time he held positions with the California State Board of Examiners, was a member of the State Board of Control, the State Tax Commission, the Civil Service Commission, and City Manager of Sacramento, Calif. Mr Draper was appointed by President Hoover in 1930, and was reappointed by President Roosevelt upon the expiration of his first term. He is the senior member in point of service, and is the only one remaining of the original members under the present organization. He was formerly a member of the Wyoming House of Representatives and State Board of Equalization and Public Service Commission, the position he held at the time of his appointment to the Federal Power Commission. He was also chairman of the committee on freight rates of the National Association of Railroad and Utilities Commissioners.

M H AVRAM, consulting engineer, has been made director of the recently organized engineering dept of Designers for Industry, Inc. He is a graduate of New York University, where he once lectured. Headquarters will be maintained in Rockefeller Center, New York, office of Designers for Industry, Inc.

JED S FOSTER, vice-president and chief engineer, Lidgerwood Mfg Co, Elizabeth, N. J., was honored at a testimonial dinner, a tribute to his 50 years of service with the company. He designed machinery used in the Panama Canal, and in the development of water power and irrigation in the United States. Mr Foster also designed the 150-ton cableway at Boulder Dam, used to convey large amounts of concrete necessary in the construction of the dam. His latest achievement is the designing of the cableway to handle the concrete at Shasta Dam in Calif. He will remain actively in his capacity as vice-president and chief engineer.

J T GILLESPIE has been appointed assistant to the president of Wilson Welder and Metals Co, affiliate of Air Reduction Sales Co, 60 East 42nd St, New York, N. Y. Mr Gillespie was formerly assistant manager of Central Div of Railroad Sales of Air Reduction Sales Corp in Chicago. In his new position he will handle promotional sales activities.

M H MONTROSS, manager, Wisconsin Valley Div, Wisconsin Public Service Corp, since 1933, has been elected to the board of directors of the company. He has been on the staff since 1925, when he went to Stevens Point from Gary, Ind., to be district manager there. He is a graduate of

Meetings

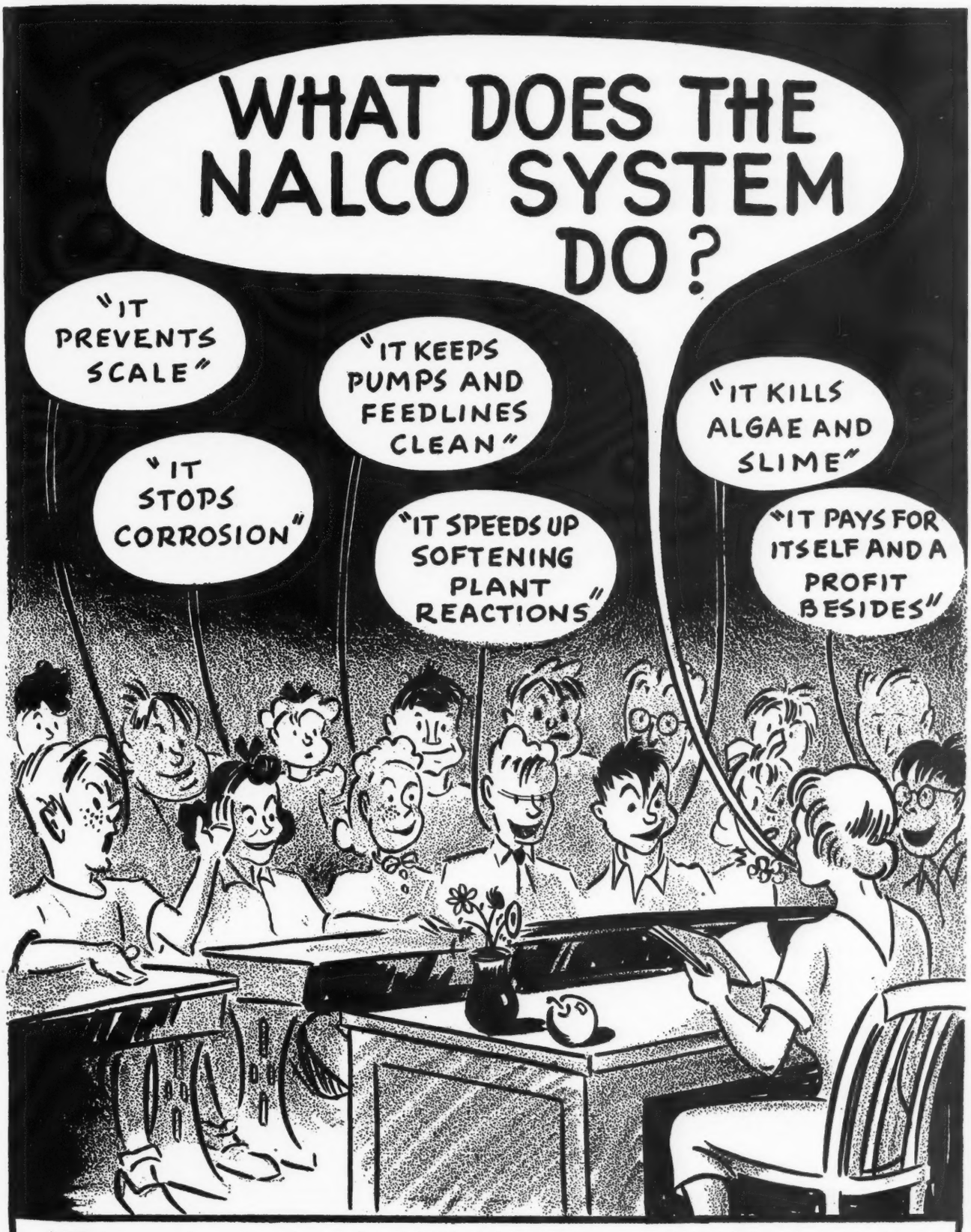
American Society of Civil Engineers—*International Fall Meeting, September 4–9, New York, N. Y. George T Seabury, secretary, 33 W 39th St, New York, N. Y.*

American Society of Heating and Ventilating Engineers—*Annual Meeting in conjunction with 6th International Heating & Ventilating Exposition, Jan 22–26, 1940, Lakeside Hall, Cleveland, Ohio. A V Hutchinson, secretary, 51 Madison Ave, New York, N. Y.*

Association of Iron and Steel Engineers—*Annual Convention and Exposition, Sept 26–29 William Penn Hotel, Pittsburgh, Pa. J L Miller, secretary, Empire Bldg, Pittsburgh.*

American Society of Mechanical Engineers—*Fall Meeting, Sept 4–8 New York, N. Y. Also Machine Shop Practice Div, "ASME Day" at Machine Tool Congress, October 5, Cleveland, Ohio, and Wood Industries Div, meeting October 12–13, Boston, Mass. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

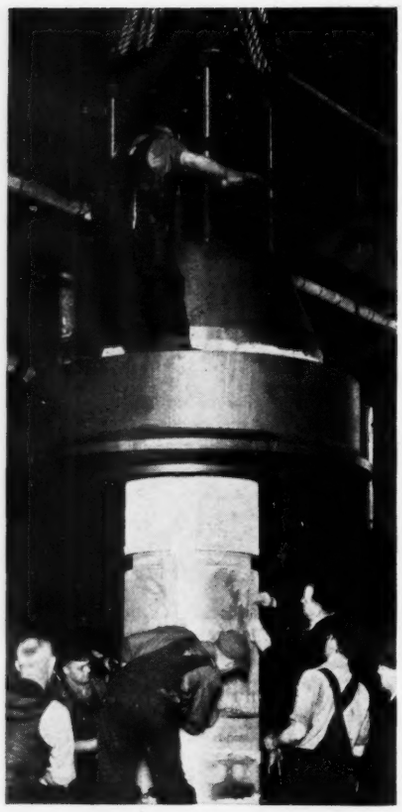
Master Boiler Makers Association—*Annual Meeting, October 16, Sherman Hotel, Chicago, Ill. Exhibit in conjunction with meeting. A F Stegemeier, secretary, 29 Parkwood St, Albany, N. Y.*


WHAT DOES THE NALCO SYSTEM DO?
"IT PREVENTS SCALE"
"IT KEEPS PUMPS AND FEEDLINES CLEAN"
"IT KILLS ALGAE AND SLIME"
"IT STOPS CORROSION"
"IT SPEEDS UP SOFTENING PLANT REACTIONS"
"IT PAYS FOR ITSELF AND A PROFIT BESIDES"

AND any smart pupil might add: "COMPLETE SERVICE . . . COMPLETE PROTECTION . . . COMPLETE SATISFACTION!" That's what you get when you adopt the Nalco System of Feedwater Treatment. We will be glad to make a survey and report on your plant without obligating you in any way. Write NATIONAL ALUMINATE CORP., 6222 W. 66th Place, Chicago, Ill.

Inquiries other than domestic, except those from U. S. Possessions, Canada and Mexico should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

THE NALCO SYSTEM OF FEEDWATER TREATMENT



COLLAR FOR CHICKAMAUGA

Shop-assembly photo of one of the three 30,000-kva, 13,800-volt generators under construction by Allis-Chalmers Mfg Co for Chickamauga Dam of TVA. It shows the 93-in. diameter thrust collar being lowered onto the upper part of the generator shaft after the latter had been shrunk down with dry ice

the Potsdam, N. Y., Institute of Technology.

S J HORRELL has been made sales manager of Power Piping Div, Blaw-Knox Co, at the company's home office in Pittsburgh, Pa. He was formerly assistant sales manager, having recently acquired that post.

ELMER H BOOZ, formerly with the Cochrane Corp, Philadelphia, has joined the staff of the Paul B Huyette Co, Inc, Philadelphia, as sales engineer.

GEORGE E CLIFFORD has been elected vice-president in charges of sales of Spang-Chalfant, Inc, Pittsburgh, Pa. He will have his headquarters in the general offices of the company in the Grant Bldg, Pittsburgh, Pa.

ROGER W ANDREWS has been appointed general sales manager of the Riley Stoker Corp, Worcester, Mass. He was with the Western Div of Combustion Engineering Co, New York, since 1934, and previous to that held positions with the Northern Equipment Co, R W Andrews Co, which he formed, the Allen-Bradshaw Co, which he also formed, and with the Tracy Engineering Co.

LELAND OLDS, of New York, former executive secretary of the New York Power

(Continued on page 156)

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Arkansas—Arkansas Power & Light Co., H. C. Couch, pres., Pine Bluff, Ark., awards contract about Sept. 1, hydro-electric dam, about 175 ft. high, across upper Ouachita River at Blakely Mount, about 14 mi. north of Hot Springs, $6,000,000-$8,000,000. **(Correction**—location of owner).

Calif., Glendale — City Council authorized construction steam-powered electric generating plant. $1,800,000. P. Diedrich, supt. P. Service Dpt. Bids will be asked at once for generator.

Conn., Norwich—Bids Aug. 21, by L. D. Wood, mgr. Gas & Electric Dpt., Shetucket St., constructing brick, steel, concrete power plant and foundation. $700,000. PWA project. A. L. Nelson, 840 Park Sq. Bldg., Boston, Mass., engr.

Conn., Rocky Hill—Hartford Rayon Corp., Rocky Hill, plans constructing power plant $125,000, and reclamation building $50,000. Private plans.

Ill., Chicago—Eastman Kodak Co., 1727 Indiana Ave., soon takes bids constructing 3 story, bsmnt., 96x175 ft. plant addition. 1712 Prairie Ave. $500,000. Schmidt, Garden & Erickson, 104 S. Michigan Ave., archts.

Ill., Chicago—Graham, Anderson & Probst & White, 80 E. Jackson Blvd., archts., plan constructing synchronous condenser house at Crawford generating station on Pulaski Rd., for Commonwealth Edison Co., 72 W. Adams St. $75,000.

Ill., Chicago—Salerno-Megowen Biscuit Co., 4500 W. Division St., soon takes bids constructing 3 or 4 story, 236x333 ft. bakery, Kostner and Armitage Aves. $1,000,000. Architect not appointed.

Ill., East Peoria (Peoria P. O.)—Central Illinois Light Co., L. E. Brown, genl. supt., plans constructing 63 ft. extension to present power plant, installing 35,000 kw. turbo-generator and 375,000 lb. boiler.

Ill., LaSalle—City, referendum next September on bonds for constructing power plant, distribution system, equipment, etc. $1,000,000. Burns & McDonnell, 107 W. Linwood St., Kansas City, Mo., engrs.

Ill., Westmont — Western United Gas & Electric Co., 50 Fox St., Aurora, soon lets contract constructing sub-station. $100,000. F. B. Gray, 73 S. LaSalle St., Aurora, archt.

Ia., Denison—City plans constructing power plant improvements, including new generating equipment.

Ia., Des Moines—Zinsmaster Breads Inc., 3rd and Market Sts., plans rebuilding plant destroyed by fire. $200,000.

Ia., Greenfield—G. V. Yarger, supt. Light & Water Dpt., plans constructing addition and alterations to municipal light and power plant, one 625 h.p. diesel generating unit and equipment, electrical work. $92,500. C. M. Stanley, Muscatine, engr.

Ia., New London—Bids Aug. 22, by Town, constructing extension to municipal electric light and power plant, one 400 kw. steam turbo-generating surface condenser, cooling tower and boiler. $50,000. Stanley Eng. Co., Muscatine, engrs.

Ia., Storm Lake—DeKalb Agricultural Assn., Inc., DeKalb, plans constructing corn seed plant, three 52x60 ft. drying buildings, 32x56 ft. processing building, 60x120 ft. warehouse. $100,000.

Ia., Storm Lake—Iowa Public Serv. Co., 517 Fifth Ave., Sioux City, plans enlarging power generating plant, and new office building. $150,000.

Kan., Larned—City takes bids early part of September, piping and auxiliaries for power plant improvements. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Ky., Owenton—City, c/o Mayor, plans constructing electric generating station and distribution system. Approximately $50,000. R. W. Chanaberry, Inc., Realty Bldg., Louisville, engr.

La., Lake Providence—Bids Aug. 22, by Mayor and Bd. Aldermen, delivering, installing diesel engine generating unit, extending power plant building, waterworks improvements in connection with combined water and light plant. Est. $125,000. C. A. Peerman, Monroe, engr.

Minn., Springfield—Bids Aug. 30, by City, for electrical construction and foundations for turbine, condenser, pumps, piping and equipment for light and power plant improvement. Total est. $142,000. PWA. Buell & Winter, 508 Insurance Exch. Bldg., Sioux City, Ia., engrs.

Mo., Nevada—City plans constructing municipal power plant. $450,000. W. Spann, Interstate Bldg., Kansas City, Mo., engr.

Mo., St. Louis—Anheuser-Busch, Inc., 721 Pestalozzi St., plans by Borsari Tank Corp. of America, 60 E. 42 St., New York, constructing 5 story fermenting and storage cellar for brewery, 9 and Pestalozzi Sts. $750,000.

Neb., Blair — City plans purchasing new diesel generating unit for light plant. Total est. $68,000. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

N. J., Murray Hill—Bell Telephone Laboratories, Inc., 463 West St., New York, plans by Voorhees, Walker, Foley & Smith, 101 Park Ave., New York, constructing laboratory building. $3,000,000.

N. Y., Ellington—New York State Electric & Gas Corp., 123 S. Cayuga St., Ithaca, plans constructing electrical plant and distribution facilities. Over $40,000. Private plans.

N. D., Minot—Bids Aug. 28, by State Bd. Higher Educ., Bismarck, furnishing new pumps for power house at State Normal School here. W. F. Burke, Fargo, archt.

O., Amherst—Village, G. C. Kasler, clk., plans nearing completion constructing municipal power plant, two 300 hp. boilers and two 400 generators. $145,000. F. G. Brown & Assoc., Marion, engrs.

O., Cincinnati—Striethmann Biscuit Co., A. P. Striethmann, pres., West 12th St. and Central Parkway, plans constructing 1 story factory, 2 story office building, new railroad siding, 15 acre site. Total est. about $2,000,000, incl. equipment and land.

O., Cleveland—Euclid Doan Co., c/o G. Harvey, 1981 East 105 St., plans by R. A. Spangler, archt. and engr., 4614 Prospect Ave., constructing power plant addition and boiler. $40,000.

O., Dayton—Dayton Power & Light Co., F. Tait, pres., Gas & Electric Bldg., plans constructing power plant improvements, incl. new substation, new transformer, revamping and remodeling existing power plant, at Millers Ford, $500,000 for buildings. Boilers awarded to Babcock & Wilcox, Carew Tower, Cincinnati; turbine, to General Electric Co., Cleveland. Total est. for materials $3,500,000, incl. transformer, switchboard, power lines, power wiring, etc. Columbia Eng. & Management Corp., 4th and Plum Sts., Cincinnati, engrs.

Tex., Weatherford—C. F. Russell, mayor, receives bids after Sept. 1 and opens same about Sept. 21, constructing electric light and power plant and distribution system. $250,000. A. C. Moore & Co., 2404-6 Smith Young Tower, San Antonio, engr.

Tex., Weimar—Town voted bonds to purchase present privately owned electric light and power plant and expansion of same. $50,000.

Wash., Stevenson — S. Samson, et al, plans constructing wood pulp and veneer plant. $500,000. RCA funds sought.

Wis., LaCrosse — Northern States Power Co., LaCrosse, soon lets contract constructing concrete work and concrete foundations for steam electric generating plant. Total est. $1,560,083. Public Utility Eng. & Service Co., 231 S. LaSalle St., Chicago, Ill., engrs.

Wis., Lake—Wisconsin Oil Refining Corp., D. E. Foster, St. Louis, Mich., plans constructing oil refining plant. $800,000.

Wis., Manitowoc—Bids Aug. 24, by Public Utilities Comn., 817 Franklin St., furnishing, delivering steam turbo-generator, condenser and auxiliary equipment.

Wis., Milwaukee — Electric Co., 231 W. Michigan St., plans by F. Luber, c/o owner, constructing 2 story, 79x134x110 ft. steel plant, Commerce St. $4,137,000. R. H. Pinkley, c/o owner, engr.

B. C., North Vancouver—Vancouver Rayon Silks Ltd., P. Zuest, mgr., Victoria, making plans constructing rayon mill on 32 acre site water front. $2,500,000. Private plans.

Newfoundland, Corner Brook—Pulp & Paper Co., Ltd., Corner Brook, making plans constructing sulphite mill. $350,000. Private plans.

Ont., Fort Erie—Fleet Aircraft Co. Ltd., W. J. Sanderson, pres., soon takes bids constructing factory addition. About $100,000.

Ont., Niagara Falls—Robin Hood Milling Co., Ltd., Moose Jaw, Sask., soon takes bids constructing sulphite mill. $350,000. Private plans.

Ont., Ridgeway — Syndicate, c/o A. D. Damued, M. P., Welland, plans constructing glass manufacturing plant and equipment. $100,000. Negotiating for site.

Ont., Wallaceburg—H. J. Heinz Co., 1062 Progress St. N.S., Pittsburgh, Pa., plans by C. A. Hahn, engr., c/o owner, constructing brick, concrete, steel plant, Forhan St. $150,000; also 1 mi. railway siding $35,000.

Que., Gatineau—Masonite Co. of Canada, Ltd., S. L. de Carteret, pres., Montreal and Gatineau, bids soon constructing factory. $150,000. Private plans.

Que., Hull — La Manufacture Belge des Raquettes, A. Andreef, genl. mgr., Brussels, Belgium, plans constructing factory. $100,000. Negotiating for site.

Que., Montreal—Ogilvie Flour Mills, Ltd., 224 Youville Square, plans constructing 200,000 bu. storage elevator with marine leg, 18 bins, etc. $500,000. R. A. Rankin & Co., 1114 Union Square, engr.

Labrador, Lake Melville—Syndicate, c/o G. H. Davidson, c/o Macfarlane Son & Hodgson, Ltd., 315 St. Alexander St., Montreal, Que., making plans constructing power plant, office building, residences and barking mill. $200,000. Private plans.

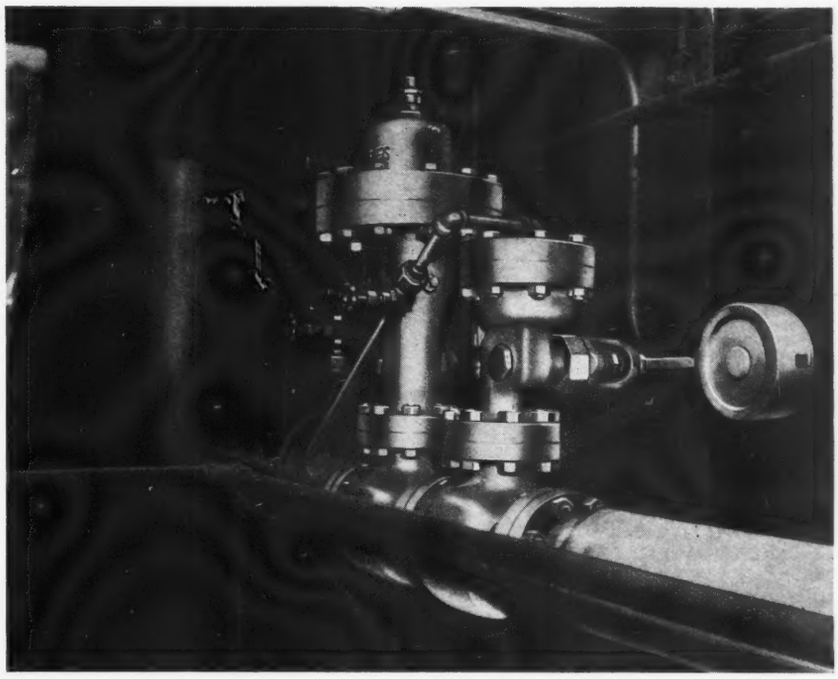
COPES IN MODERN BREWERIES

COPES Feed Water Regulators are saving time for the boiler plant operators, and saving money for the owners, of these breweries:

Acme Breweries, San Francisco, Calif.
Ahrens Brewing Co. . . . . Tulsa, Okla.
American Brewing Co., Rochester, N.Y.
Anheuser-Busch, Inc. . . . St. Louis, Mo.
Atlantic Brewing Co. . . . . Chicago, Ill.
Balboa Brewing Co., Los Angeles, Calif.
Banner Brewing Co. . . . Saginaw, Mich.
Berghoff Brewing Co., Ft. Wayne, Ind.
John F. Betz & Sons . . Philadelphia, Pa.
Centlivre Brwg. Corp., Ft. Wayne, Ind.
Christ. Feigenspan Corp., Newark, N.J.
Clyffside Brewing Co., Cincinnati, O.
F. W. Cook Brwg. Co., Evansville, Ind.
Cumberland Brewing Co. . . . . Cumberland, Md.
Dobler Brewing Co. . . . . Albany, N.Y.
Falls City Brewing Co. . . Louisville, Ky.
Falstaff Brewing Corp. . . . St. Louis, Mo.
German Brewing Co., Cumberland, Md.
Gleuck Brwg. Co., Minneapolis, Minn.
M. K. Goetz Brwg. Co., Kansas City, Mo.
Grace Bros. Brwg. Co., Santa Rosa, Calif.
Griesedieck Bros. Brewing Co. . . . . St. Louis, Mo.
Haffenreffer & Co. . . . . Boston, Mass.
Hudepohl Brewing Co., Cincinnati, O.
Huebner Toledo Brwg. Co., Toledo, O.
John Labatt, Ltd. . . . . London, Ont.
Lieber Brewing Co., Indianapolis, Ind.
Minneapolis Brewing Co. . . . . Minneapolis, Minn.
Harry Mitchell Brwg. Co., El Paso, Tex.
Molson's Brewery, Ltd. . . Montreal, P.Q.
National Breweries . . . . . Montreal, P.Q.
Neuwiler's Brewery . . . . Allentown, Pa.
New Haven Brewery, New Haven, Conn.
Oertel Brewing Co. . . . . Louisville, Ky.
Olympic Brewing Co., Olympic, Wash.
Pabst Brewery . . . . . Saskatoon, Sask.
Pfeiffer Brewing Co. . . . . Detroit, Mich.
Pilsner Brewing Co. . . . . Portland, Ore.
Rahr Green Bay Brewing Co. . . . . Green Bay, Wis.
Rahr Malting Co. . . . . Manitowoc, Wis.
Red Top Brewing Co. . . . Cincinnati, O.
Regal Brewing Co. . . . . Detroit, Mich.
Rio Grande Brewing Co. . . . . Albuquerque, N.M.
Jacob Ruppert Brewery, New York, N.Y.
Seattle Brwg. & Mltg. . . Seattle, Wash.
Shea's Winnipeg Brewery . . . . . Winnipeg, Man.
Adam Scheidt Brewing Co. . . . . Norristown, Pa.
Southern Breweries, Inc. . . Norfolk, Va.
Standard Brewing Co. . . Rochester, N.Y.
Terre Haute Brewing Co. . . . . Terre Haute, Ind.
Theo. Hamm Brwg. Co., St. Paul, Minn.
West End Brewing Co. . . . . Utica, N.Y.

Write for . . .

8-page illustrated bulletin—How COPES Controls Flow, Level and Pressure for one of America's best known brewers. Your letterhead, please.



At Jacob Ruppert Brewery:

There have been no water level difficulties on Jacob Ruppert Brewery's new C-E Type VU Steam Generators. The level is closely stabilized on the sharpest load swings by the COPES Flowmatic Regulator and Differential Valve in service on each 410-pound pressure unit. And this COPES control is setting a splendid record for dependability, thanks to simple design and extra-rugged construction. It requires no more attention than a water column. Performance like this makes possible sizeable savings in operating costs. Write, on your letterhead, for Bulletin 409-B, which tells the interesting story of the modern COPES Flowmatic.

NORTHERN EQUIPMENT CO., 911 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY AND ITALY
REPRESENTATIVES EVERYWHERE

Get closer level control with the

COPES

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

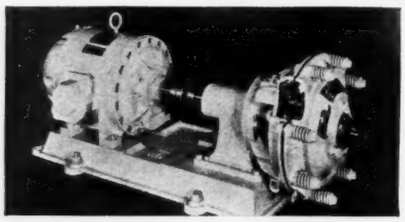
FLOWMATIC

★ REGULATOR

What's New In Plant Equipment

Glass Pump

CONSTRUCTED of "Pyrex" brand heat and shock-resisting glass, pump impeller and casing not affected by temperatures up to 150 F, in standard design, and 200 F in special design. Fully transparent, the interior of pump and materials being handled

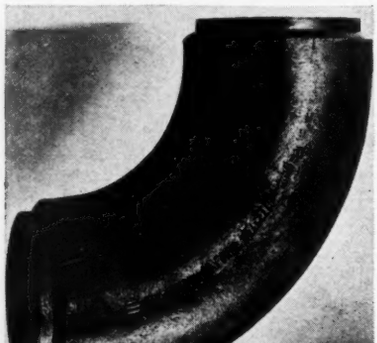


can be seen at all times. Dangerous pressure relieved automatically if it should develop on the interior of pump. Hot acids or brine cooled liquids can be pumped with equal ease, according to manufacturer.

Nash Engrg Co, South Norwalk, Conn.

Welding Fitting

WELDELLS have annular lip forged integral with fitting, said to eliminate need for backing rings, clamps and guides to hold material in position. Ring stays cooler during welding operation than sides of pipe, therefore making opening darker and aiding welder determine when com-

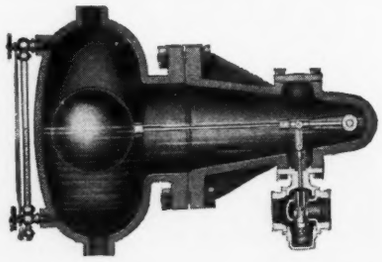


plete penetration, without burning through, has been accomplished. WeldELLS are full pipe thicknesses throughout with reinforcements in parts of stress. Also have tangents, machine-tool bevels, ends marked in quarter sections, and name, size and weight rolled into each fitting.

Taylor Forge & Pipe Works, P O Box 485, Chicago, Ill.

Feedwater Regulator

MECHANICAL, direct-feed operation of regulator said to eliminate delays in supplying makeup water. Boiler water level required for safety reproduced in float chamber of



regulator, and drop in level causes float-controlled feed valve to open in proportion to decrease in water level. Can be installed singly or in batteries, and can be adjusted to start or stop stokers and burners.

McAlear Mfg Co, 1901 S Western Ave, Chicago, Ill.

Short-Wave Radio Telephone

OUTPUT of new instrument stepped up to 15 watts, triple amount of power formerly used without extra drain on storage battery. Coupling arrangement transfers almost all energy from vacuum tubes to antenna. Equalizer blocks out most electrical interference, while automatic volume control maintains speech at constant level. New type vacuum tube relay used in "codan" circuit, operated on carrier waves from distant station. When no signal comes through, codan shuts off output of receiving set, eliminating almost all sound from handset receiver except during transmission periods. Transmitter and receiver slide into slotted mounting plates attached to floor of car's luggage compartment, permitting easy removal if necessary. All tuning adjustment can be made with screwdriver or "trimmer" tool. Self-contained dynamotor in transmitter and vibrator element in receiver makes up power-supply apparatus.

Western Electric Co, 195 Broadway, New York, N.Y.

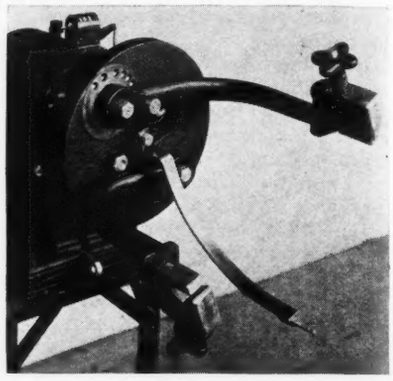
Unit Heater

MANUFACTURED in 16 sizes to meet various conditions requiring space heating, unit uses either steam or hot water. Case is crackle finish, trimmed with chromium strips. Heating elements are heavy-wall copper tubes, and condenser is "full floating" to overcome contraction and expansion. Equipped with enclosed motor.

D J Murray Mfg Co, Wausau, Wis.

Armature Winding Yoke

"IDEAL" yoke will hold any armature with shaft from 9 to 19 in. long. Wires guided into slot by hand, enabling operator to wind armatures in lathe or special coil-winding machine. Has two cast-iron arms fastened to round cast-iron mounting base which can be adjusted to increase or decrease amount of yoke span by swinging them toward or away from center of disks. Each arm has index pin which falls into corresponding holes on base plate, said to insure centering of work. Nine index holes provided, giving equal spacings from 9 to 19 in. mentioned. Third arm is used to

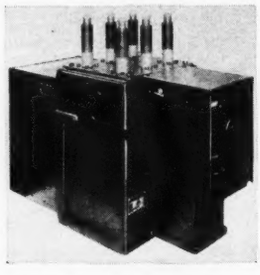


form loop after winding each coil, by twisting wire around pin before starting next loop.

Ideal Commutator Dresser Co, 1025 Park Ave, Sycamore, Ill.

Air Circuit Breaker

"MAGNE-BLAST" breaker intended for general application in switching, controlling and protection 2300- to 5000-volt circuits. Important design feature is interleaving chute formed by long, tapered fins alternating from either arc chute wall and ex-



tending from the throat and arc runner to mouth of arc chute. Arc is cooled and lengthened in the interleaving chute, adding resistance to circuit as arc is extinguished.

General Electric Co, Schenectady, N. Y.

Dust Collector

"THERMIX" tubular dust collector is series of steel tubes, each equipped with 2 slots in upper half, which in turn has directional vane on exterior of tube. Lower half of tube extends into dust hopper through tube sheet. Gas enter inlet plenum chamber and passes through slots in tubes, rotating around a small tube. Central tube extends somewhat below bottom of slots in the outer tube and upward to tube sheet which forms bottom of outlet duct. Dust is precipitated against the sides of

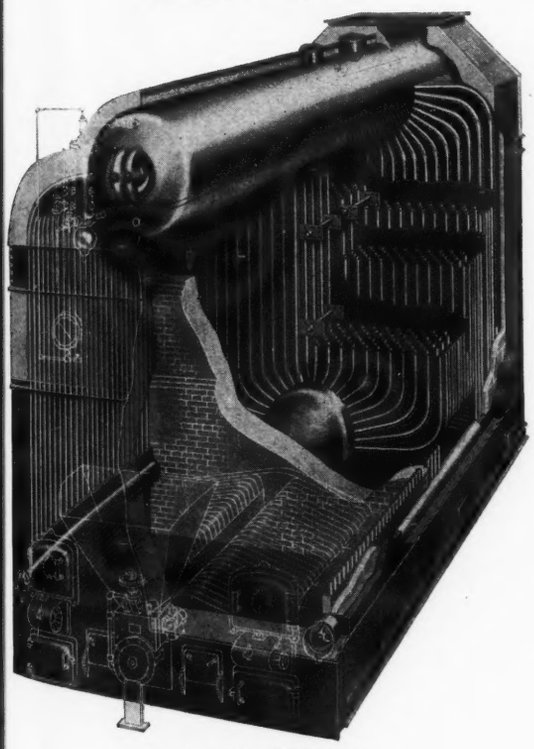
QUESTION?

WHY does the KEELER C P Steam Generator continue to lead the field?

ANSWER!!!

BECAUSE all its advantages can be found in no other boiler of similar design. It is the original of its type.

Capacities to 50,000 lbs.
Pressures to 450 lbs.



Patent No. 2097268

REPEAT ORDERS SIGNIFY SATISFIED CUSTOMERS. ONE NATIONALLY KNOWN CORPORATION HAS PLACED THEIR FOURTH ORDER WITH US TOTALING EIGHT GENERATORS IN ALL.

ADVANTAGES

1 **Steel cased and insulated**

2 **Expensive Masonry eliminated**

3 **Water cooled side walls**

4 **Clinkers cannot cling to walls**

5 **Low furnace maintenance**

6 **More capacity in given space**

7 **Steady water level at all ratings**

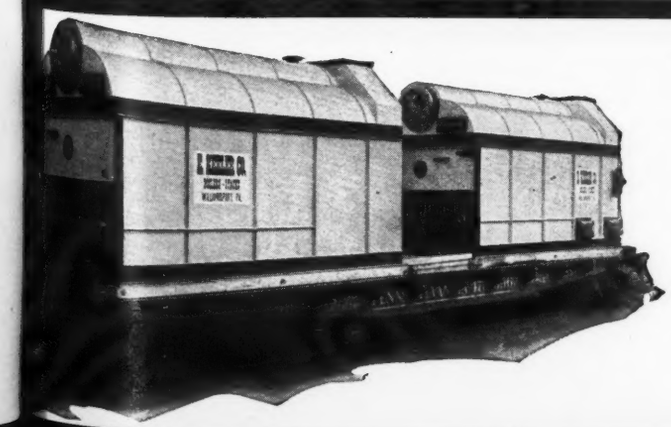
8 **Built in soot blower**

9 **Larger furnace with less head room**

10 **Capable of high overloads**

Note: Also manufactured in Canada by Canadian Vickers, Ltd., Montreal.

300 INSTALLATIONS ARE PAYING DIVIDENDS TO THEIR OWNERS



SEND COUPON FOR BULLETIN F9.

E. KEELER COMPANY

BUILDERS OF BETTER BOILERS WILLIAMSPORT, PA.

NAME ..... POSITION.....

COMPANY .....

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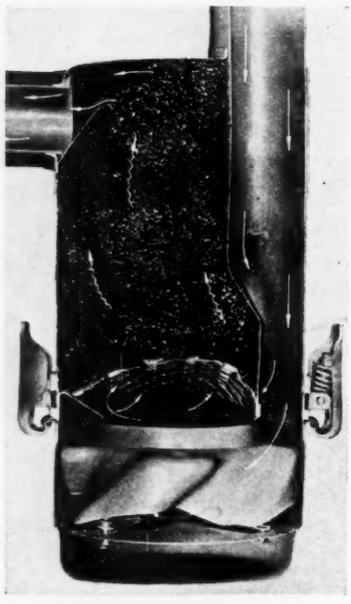
CITY ..... STATE.....

the outer tubes and is carried down the walls of the tube into the hopper. The cleaned gas is evacuated through the smaller central tube to the outlet duct. Catalog 107.

Prat-Daniel Corp, Port Chester, N. Y.

Air Cleaner

OIL-BATH air cleaner made so that air, as it enters cleaner, is made to whirl rapidly, producing vortex action and picking up oil from reservoir. Then sprays on impingement surfaces of vortex chamber, and into filter element, thoroughly wash-



ing it of dust. Oil-drains from filter element carrying small amount of dust taken to oil reservoir. Air inlets of filter submerged in oil, so that oil is carried into filter element by first revolution of engine. Built in 2 types, for horizontal and vertical operation.

Vortox Mfg Co, Claremont, Calif.

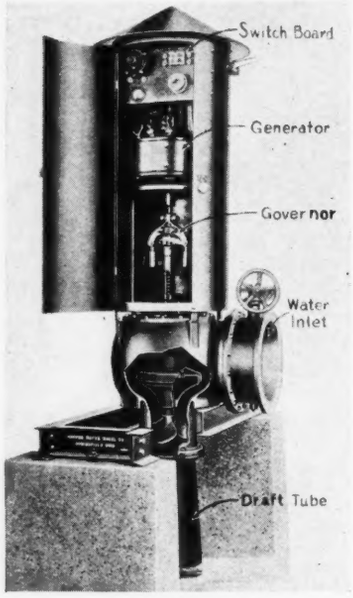
Cutting Compound

COLLOIDAL GRAPHITE "Dag" suspended in mineral oil said to be effective cutting compound, to provide free cutting action and insure long tool life. Single drop of concentrated solution sufficient for tapping 5 holes, according to manufacturer. Where tapping equipment is provided with coolant pump, circulating or volume supply system, concentrated "oil dag" may be diluted in ratio of 15 oz of colloidal graphite to 2 gals. of mineral oil.

Acheson Colloids Corp, Port Huron, Mich.

Hydroelectric Unit

HOPPES unit designed to provide power source from small water power. Switchboard, generator, and governor are inclosed in a circular casing above the water

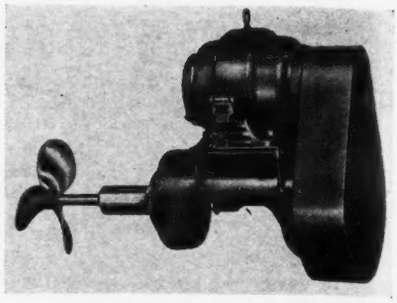


wheel as protection from weather. Vertical design permits placing electrical equipment above flood water. Unit mounted on I-beam foundation for easy installation. Unit started and stopped by worm-gear-operated butterfly valve in water-wheel intake. Speed regulated by governor on turbine shaft. Units built in 0.5- to 10-kw capacity for 8 to 30-ft heads.

James Leffel & Co, Springfield, Ohio

Side-Entering Mixer

"LIGHTNIN" mixer has motor mounted on steel platform actuated by riser bolt, allowing for maximum adjustment for belt tension or bearing replacement. Has cartridge-type rear bearing, belt-guard and frame on Vee-Belt model. Recommended for service where quietness is necessary,



and where change of motors is important. Silent-chain drive can be substituted for belt.

Mixing Equip Co, Inc, Rochester, N. Y.

Electric Resistance Welding Process (1)

DESIGNED primarily for use with stainless-steel tubing and bellows, development permits fabrication of completely sealed vacuum-tight units free from soldered, brazed or torch-welded joints of any kind. Said to be ideal in corrosive atmospheres, where silver solder was formerly used. Automatic equipment makes circumference seam-welding possible without manual operation. Thin gages of metal said to be readily adaptable, and different thicknesses of material can be joined.

Chicago Metal Hose Corp, Maywood, Ill.

Constant-Level Oilers (2)

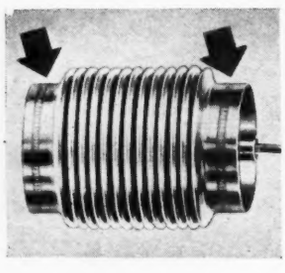
VISIBLE, automatic, constant-level oilers have unbreakable reservoirs and adjustment oil level features. One filling of reservoir said to lubricate bearing 3 months and longer. Reservoir attached to lower casting by threaded spout easily removed for cleaning or refilling. Available in 1-, 2-, 4-, and 8-oz capacities with all bottles interchangeable. Two styles for standard- and high-surge levels have side outlets only, and bottom outlets for bottom connection or for draining purposes.

Trico Fuse Co, Milwaukee, Wis.

Hole Saws (3)

LINE of high-speed hole saws used in $\frac{1}{2}$-in. or larger electric drills, and mandrel adaptable for $\frac{1}{4}$- and $\frac{3}{8}$-in. drills. Number of applications includes installation of stokers and automatic blowers in furnaces, setting new dials in instruments, etc.

Black & Decker Mfg Co, Towson, Md.



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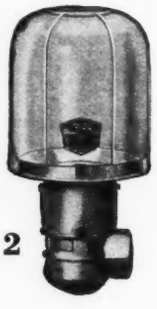

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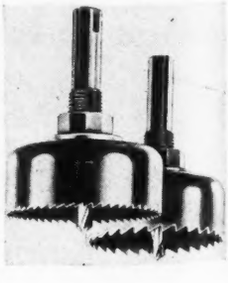
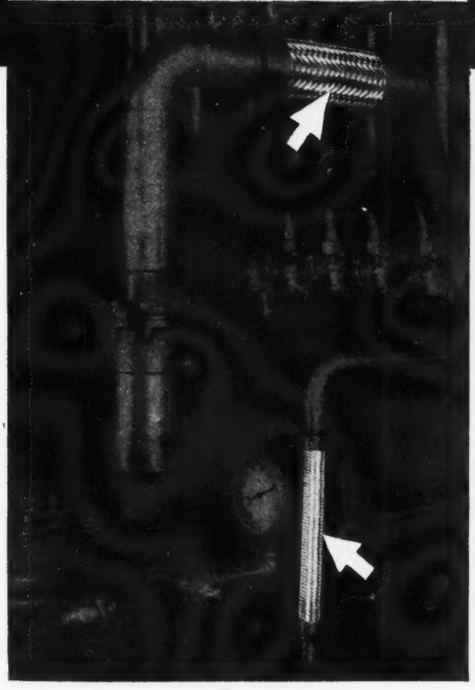


Most reliable where **100%** *tightness is essential...*

American Seamless Flexible Metal Tubing

For vibration and thermal expansion—
American Vibration Eliminators

For use in rigid pipe lines where vibration and noise must be eliminated and provision made for expansion of the line. Stocked as complete units for immediate shipment. Sizes up to 3″ I. D.

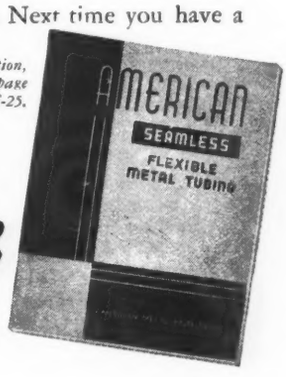


THOUSANDS of successful industrial installations have proved that American Seamless is the most effective answer to flexible metal tubing problems where constant flexing, permanent and complete tightness, expansion or vibration are important considerations. Why? . . .

Because it has no welds, joints, laps, seams or packing and is as tight for the conveying of air, gas, steam and fluids as the rigid seamless tube from which it is made . . . because it can be used under any temperatures up to the point where the heat will affect the physical structure of the metal itself . . . because it withstands high pressures (½″ I. D. with two braids has a hydrostatic bursting pressure of 5000 lbs. per sq. in.) . . . because in several different types of installations, American Seamless has flexed millions of times without breaking.

Benefit by these exclusive advantages. Next time you have a flexible connector problem, solve it with American Seamless. 39239

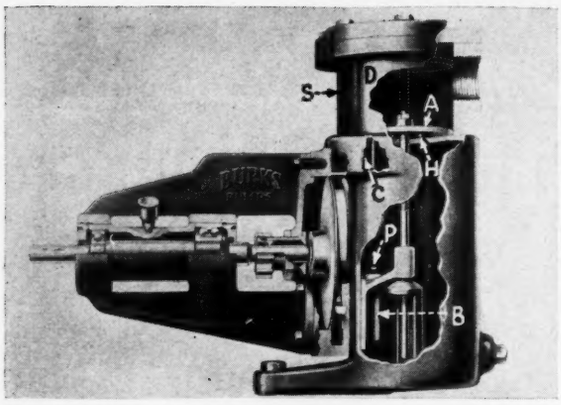
For complete information, write for our new 24-page manual, Bulletin SS-25.

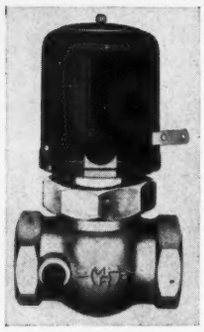


American Metal Hose

ANACONDA
From mine to consumer

AMERICAN METAL HOSE BRANCH OF THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Connecticut • Subsidiary of Anaconda Copper Mining Company





Self-Priming Pump

BURKS PUMP starts as self-priming unit and automatically changes to conventional centrifugal operation after it is primed. The suction and discharge pipe each connect to the top of vertical cylinders *S* and *D* respectively. After pump is primed these cylinders retain a supply of water at the impeller for priming on the next start. Suction cylinder *S* does not have any mechanism, but discharge cylinder *D* contains automatic primer cutout. This comprises a disk *A* and bronze segment *B* fixed to the same shaft. When starting, water is taken from suction chamber into the eye of the impeller, which is semi-enclosed, and discharged through passage *C* to the discharge cylinder *D*. Any excess of water coming into discharge cylinder builds up a pressure that lifts disk *A* and tends to rotate it and segment *B*, because of the rotary action of the water. As water level in the suction cylinder is reduced it is replaced by water leaking into it from discharge cylinder through port *P*. This mixes with incoming air and is discharged into discharge cylinder where the air rises into the discharge pipe. If there is insufficient water in the pump to lift disk *A* the air is liberated through holes *H*. When pump is fully primed, force of the discharge lifts and rotates disk *A* to top of the cylinder, as shown by the dotted lines. This action also lifts and rotates segment *B*, and when in position shown by dotted lines, its rotation and that of the disk is stopped by a pin on the inside of the cylinder. In that position segment B covers priming port *P* and prevents further water circulation between discharge and suction. Then pump operates like a conventional centrifugal pump with a semi-enclosed non-clogging impeller. Built for capacities up to 450 gpm and for total heads up to 130 ft.

Decatur Pump Co, Decatur, Ill.

Gas Valve *(above)*

MODEL V155 is new design of previous Model V15 motorized gas valve. New valve is equipped with "locking screw" which, after removal, will allow gas valve to close under control of thermostat, should damper arm bind and fail to close, but will not allow it to open until damper has been repaired. Valve may be opened manually with screw in place in case of electric failure. When power supply is resumed, valve automatically returns to control of thermostat. Sizes from ¾ to 2½ in. available, for ac current only, and for gas pressures not over 4 oz.

Minneapolis-Honeywell Regulator Co, 2950 Fourth Ave South, Minneapolis, Minn.

Vacuum Attachment

"SKRAPTRAP" arrangement collects small objects such as nails, bolt, screws, etc, which have been drawn into portable

blower, used as vacuum cleaner. Attachment prevents objects from entering and injuring fan blades. Normal dust and lint collected by cleaner passes into bag.

Breuer Electric Mfg Co, 5100 N Ravenswood Ave, Chicago, Ill.

Sound-Insulated Pillow Block

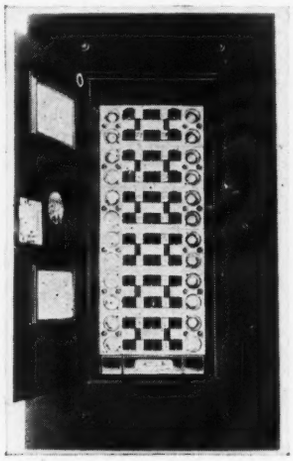
SERIES ED-R pillow blocks said to be completely insulated by molded cushion of Neoprene, and are applicable to light service, such as domestic air-conditioning units, fans, etc, where silent operation is desirable and necessary. Seals, of floating construction, are also Neoprene. Provision made for normal misalignment, and bearing is electrically grounded. Housings are solid die-castings, compact and clean-lined. Shaft sizes are ½, ⅝, ¾, 1⅛, and 1 in.

Ahlbery Bearing Co, 3025 W 47th St, Chicago, Ill.

Safety Switch And Panelboard

"ROCKER" type safety switch, 30-amp front-operated, has curved molded handle which is rocked by thumb action to "On" or "Off" position. Handle and switch mechanisms are all one piece, operating on knife-edge bearings. Provision made for marking circuit information on handle of

switch. Rocker type panelboards are porcelain for maximum dialectric strength and are said to be resistant to heat. Available in circuits of 4 to 40, in multiples of 4, with quick make-and-break switch action, exposed screw-type wiring termin-



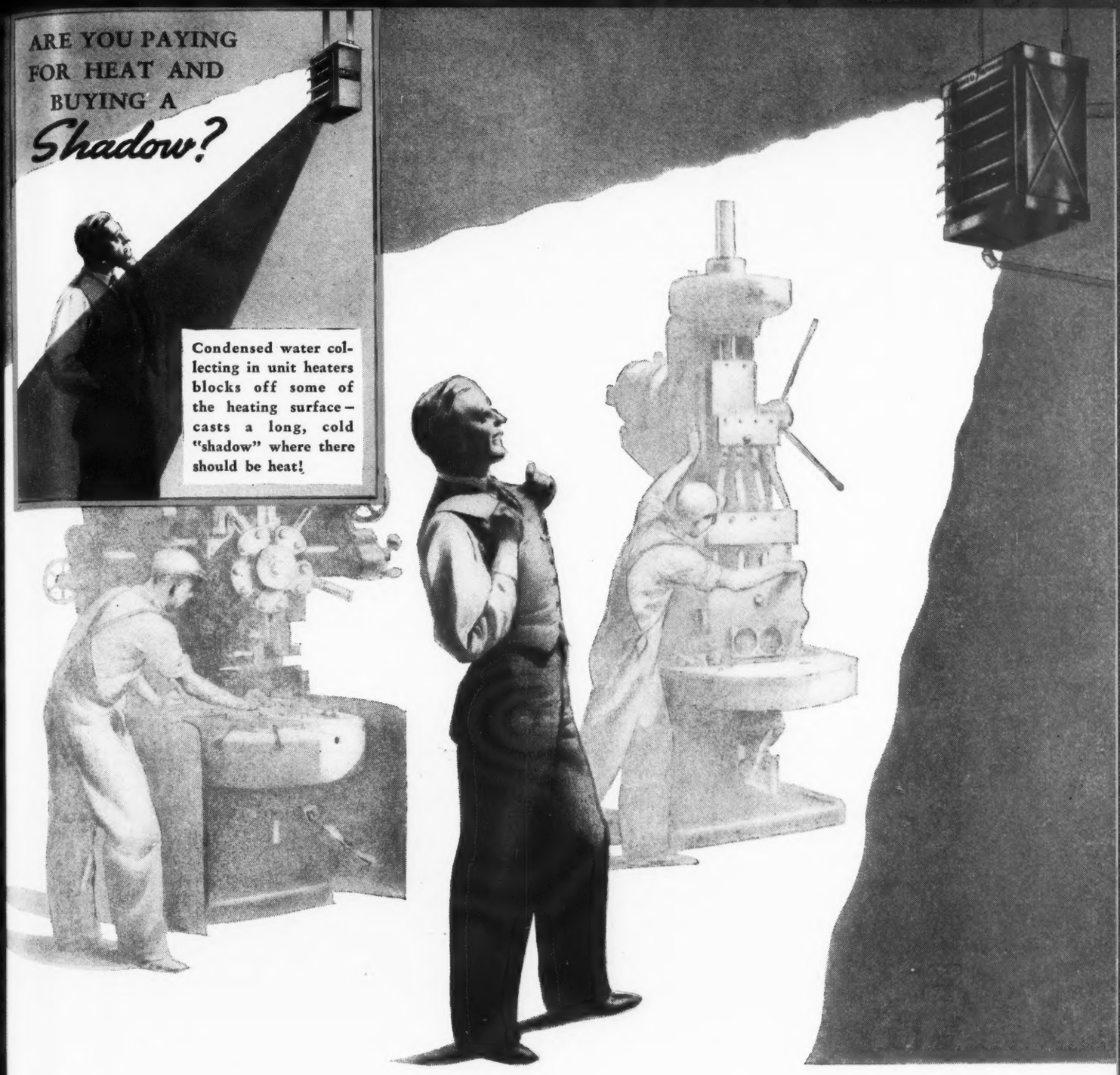
als, and silvered-surfaced current-carrying parts. Folder 393 and Bulletin 392.

Bull Dog Electric Products Co, 7610 Jos. Campau Ave, Detroit, Mich.

Priming Equipment

CONSTRUCTED for centrifugal pumps located above source of supply, priming system keeps water level on suction side of pump above eye of the impeller, vacuum-producing device being called on after only in cases of exceptional air leakage and when pump is not running. Where main pump is not designed to run dry, or unprimed, it is automatically shut down should breaks appear in line. When pump will not be damaged by running dry, slight change in

(Continued on page 136)


ARE YOU PAYING FOR HEAT AND BUYING A Shadow?
Condensed water collecting in unit heaters blocks off some of the heating surface – casts a long, cold "shadow" where there should be heat!

NO *"SHADOWS"* TO PAY FOR WITH THERMOLIER!

Thermolier's broad, continuous beam of heat is never "shadowed" – because condensate is drained *continuously* by the Internal Cooling Leg, exclusive with Thermolier. All of the heating surface *works*, all of the time.

Grinnell's 50 years of heating experience created the Internal Cooling Leg . . . plus *13 other* outstanding points of superiority. They're all described in the 48-page Thermolier Data Book that covers Thermolier's 3 types and 30 sizes. Send for a copy. Grinnell Company, Inc., Executive Offices, Providence, Rhode Island, branch offices in principal cities of the United States and Canada.

USERS REPORT:

75 tons less coal used per season – saving 35% – since Thermoliers were installed in a Railway and Dock Shop.

29% less steam consumed, after Thermoliers went into a well-known textile plant.

Manufacturer with over 50 plants averages overall savings of 30%. $50 per day in one plant alone, $5500 per year in another.

GRINNELL THERMOLIER

THE UNIT HEATER WITH 14 POINTS OF SUPERIORITY

Old-Fashioned Employee Relations . . .

EVERY TIME I hear or see something about "employee relations" or "industrial understanding", it reminds me of a boss I had when I was a kid. It was a small plant, and the boss was BOSS. He was stricter than the devil, but he was a straight-shooter too. He didn't expect something for nothing, and we learned to be the same way. When this modern "relations" talk simmers down to fundamentals, it comes all-fired close to what the boss stuck up around the shop as his "Ten Demandments". Here they are—every one worth an editorial all by itself:

George Edwards
Engineer

TEN DEMANDMENTS

I. Don't lie. It wastes my time and yours. I'm sure to catch you in the end—and that's the wrong end.

II. Watch your work, not the clock. A long day's work makes a long day short, and a short day's work makes my face long.

III. Give me more than I expect, and I'll pay you more than you expect. I can afford to increase your pay if you increase my profits.

IV. You owe so much to yourself that you can't afford to owe anyone else. Keep out of debt or keep out of my plant.

V. Dishonesty is never an accident. Good men, like good women, can recognize temptation when they meet it.

VI. Mind your own business, and in time you'll have a business of your own to mind.

VII. Don't do anything here which hurts your self-respect. The employee who is willing to steal for me is willing to steal from me.

VIII. It's none of my business what you do at night. But if dissipation affects your work the next day, and you do half as much as I hoped, you'll last half as long as you hoped.

IX. Don't tell me what I'd like to hear. I don't want a valet for my vanity, but I need one for my money.

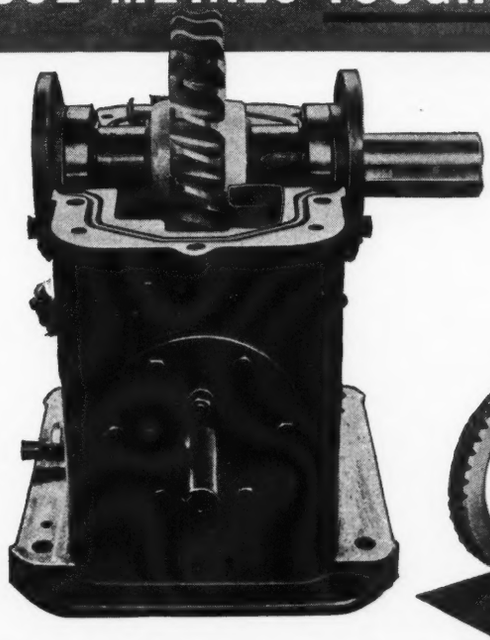
X. Don't kick if I kick. If you're worth correcting, you're worth keeping. I don't waste time cutting specks out of rotten apples.

— THE BOSS

REDUCE WEAR . . . IN SPEED REDUCERS

Belt conveyor in the Coniston smelter at Copper Cliff, Ontario. The speed reducer, built by Cleveland Worm & Gear Co., uses 3 1/2% Nickel steel (SAE 2315) in worms. Gears are 1 1/2% Nickel bronze. Metals alloyed with Nickel burnish to a mirror-smooth surface, maintain alignment, and reduce power transmission losses.

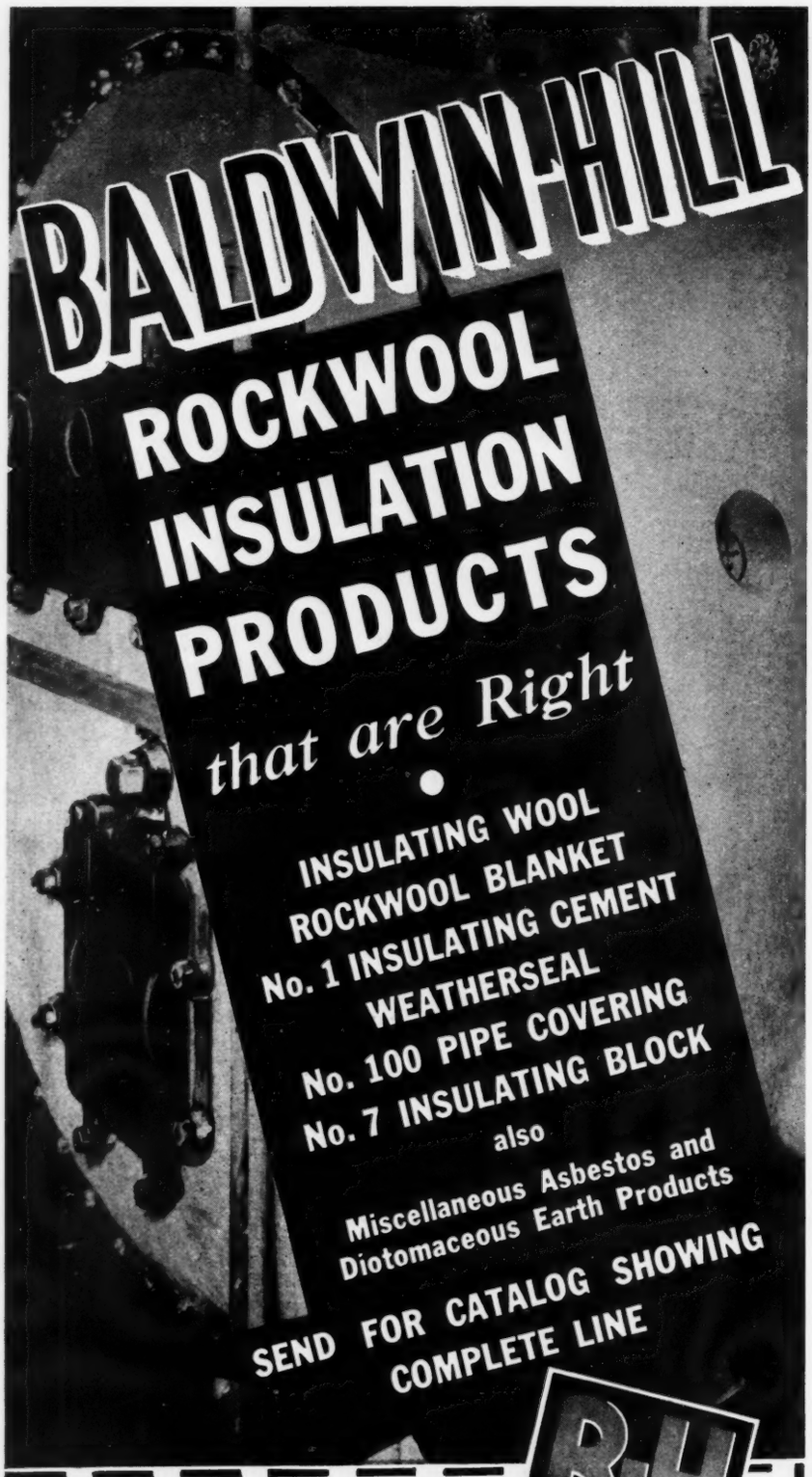
. . . USE METALS TOUGHENED WITH NICKEL



Cleveland Worm & Gear Co. speed reducer parts strengthened with Nickel. The 43" bronze gears containing 1 1/2% Nickel, provide 50:1 ratios. The 11 3/16" gear of the same material in left foreground—is a 9 2/3:1 ratio. All worms are 3 1/2% Nickel steel, SAE 2315. Extra toughness of Nickel alloy steel guards against breakage, delivers longer service at lower cost per year.

Top housing of Cleveland type AT speed reducer removed to show oil scrapers and grooves. The dense grain structure of this bronze gear, toughened with 1 1/2% Nickel, provides surface hardness with high core strength, minimizes wear and prolongs life.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.



BALDWIN-HILL CO.
575 KLAGG AVE., TRENTON, N. J.
PLEASE SEND CATALOG TO—

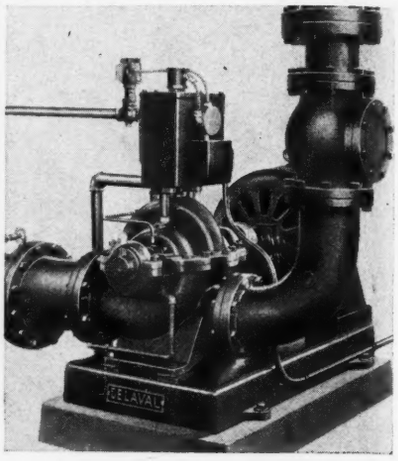
NAME_____

COMPANY_____

ADDRESS_____ CITY_____ STATE_____

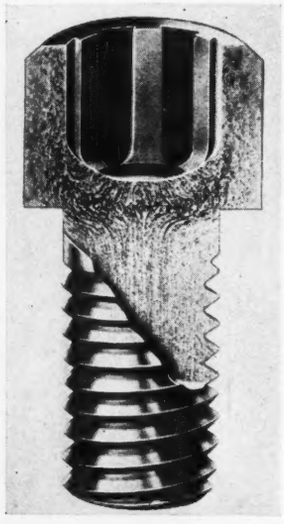
New Equipment

(Continued from page 132)



electrical and sealing connections provides for priming while in operation. System remains in operation as long as electric power is available for main pump motor. No check or foot valve required in main pump suction line, and no manual attention necessary.

De Laval Steam Turbine Co, Trenton, N. J.



Cap-Screw

"BRISTO" cap screw has patented head which provides socket with splines by machine built for purpose. Manufacturer claims turning force of screw increased by addition of these splines to socket. Illustration shows fibrous grain structure of cap screw, said to assure turning force in direction of rotation without tendency to split.

Bristol Co, Waterbury, Conn.

Arc Welder

MODEL 400 BT, 350-amp welder said to operate at full capacity continuously and to deliver strong arc at any degree of heat. Heat range is from 30 to 350 amp inclu-

The superintendent of this boiler manufacturing plant says . . .

"WE HAVE SAVED IN OUR INSTALLATION COSTS"—WITH Electrunite-

REG. U. S. PAT. OFF.

Photograph of National Radiator Premier Steel Boiler

THE MODERN ELECTRIC RESISTANCE WELDED BOILER TUBES

HERE'S WHAT the steel boiler plant superintendent of The National Radiator Company, Johnstown, Pa., says about ELECTRUNITE:

"We have been using ELECTRUNITE Tubes for the past five years, and we are well satisfied. Our requirements cover tubes from 2" to 4" in diameter and of varying gauges, and we have always found these tubes to be uniform in wall thickness and in diameter.

"In many instances we have made considerable savings in our installation costs due to their uniformity and smooth surfaces as compared with some other types of tubes.

"Up to this time we have never been called upon to replace a set of ELECTRUNITE Tubes due to failure or defects." More of his comments are shown under illustrations at the right.

Other ELECTRUNITE users report similar savings as high as 20%. Let us show you what ELECTRUNITE can do for you.

"Even with a close tube hole clearance, such as we use in our product, no trouble is experienced when installing these tubes."

"Our tubing gang like these tubes because they can be easily rolled and beaded, and are of uniform hardness."

"Since using ELECTRUNITE Tubes we have eliminated entirely the necessity for replacing split boiler tubes."

Steel and Tubes, Inc.

WORLD'S LARGEST PRODUCER OF ELECTRICALLY WELDED TUBING

CLEVELAND . . . OHIO

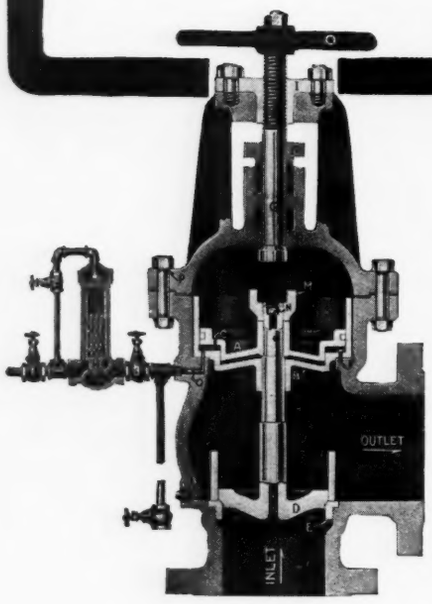
SUBSIDIARY: REPUBLIC STEEL CORPORATION

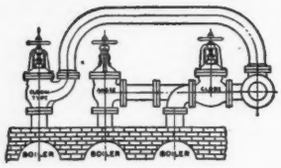
★

Golden-Anderson

SPECIALTY

VALVES





TRIPLE ACTING NON-RETURN

● No boiler plant is *safe* without them! Protect life and property against boiler explosion or bursting steam line. Double cushioned, will not stick or chatter. Can be tested any time, under pressure. The heaviest valves of this kind made . . . 2½" to 16" sizes in angle, globe or elbow types, with either flanged ends or welding necks . . . for 150 lb. to 1500 lb. service.

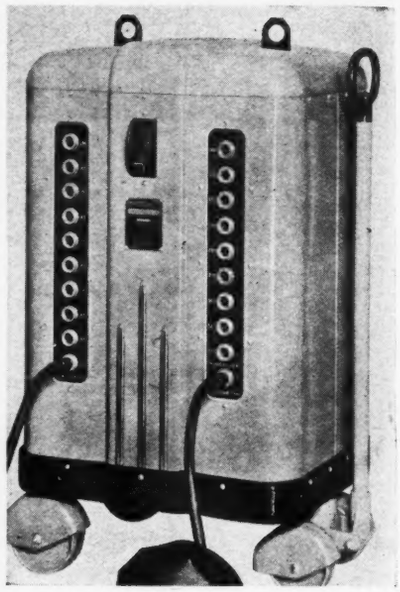
Ask for illustrated catalog

also

Altitude Control . . . Pressure Reducing . . . Throttle and Emergency Stop . . . Check . . . and other types of valves.

Golden-Anderson Valve Specialty Co.

Fulton Bldg. • • • Pittsburgh, Pa.

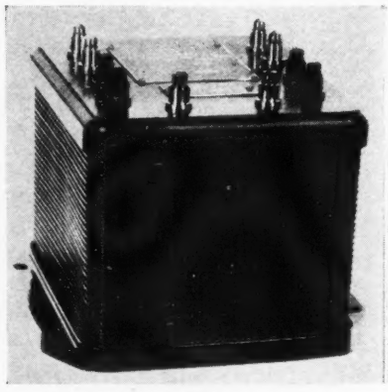


sive, with separate tap for each of 19 heat-stages. Amperage for each tap marked, and welder has no moving parts. Model illustrated mounted on truck for portable operation.

Marquette Mfg Co, Minneapolis, Minn.

Thermal Converter

"THERMOVERTER", when connected in ac metering circuit, performs conversion from ac watts to dc millivolts. Power load may be directly expressed by dc potential difference suited to transmission over considerable distance. Has no make-and-break

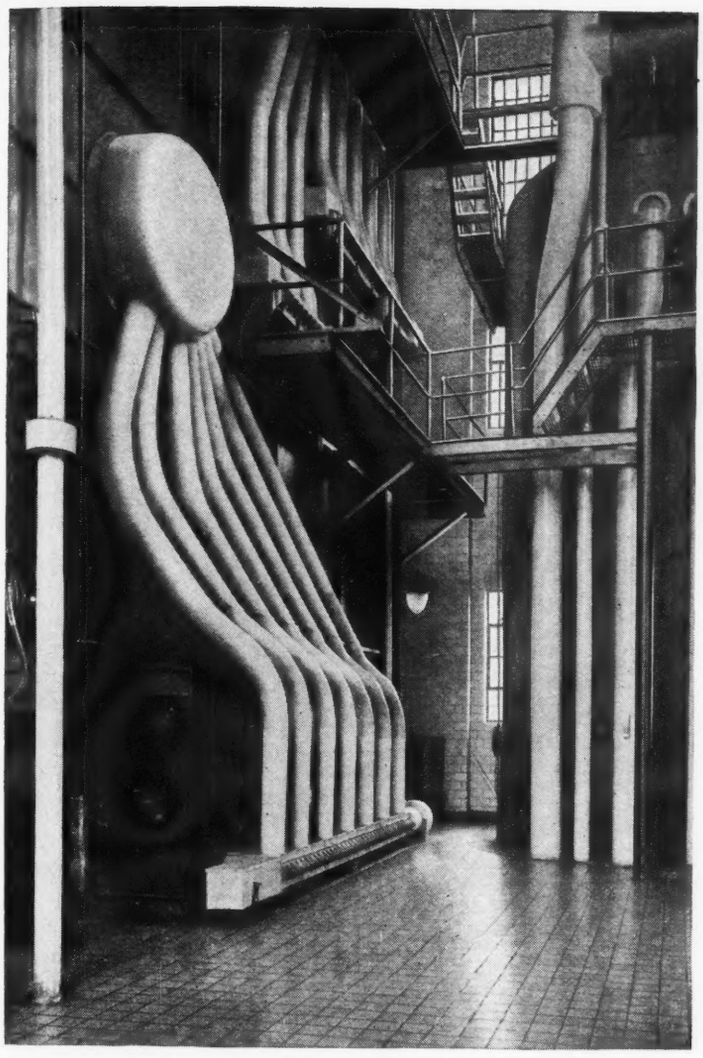


contacts, field adjustments, or moving parts. With either direct-deflecting millivoltmeter or potentiometer as measuring instrument, thermoverter can measure ac power in one or a number of circuits and telemeter ac power or totalized load.

Bristol Co, Waterbury, Conn.

Ball-Bearing Idler

TYPE B-304 idler designed for handling materials of medium weight, consisting of fines and small lumps such as shavings, wood chips, ashes, etc. Suitable for conveyor widths of 14 to 30 in. inclusive, has idler rolls made from 4-in. smooth-finished steel tubing with formed heads pressed into and welded to each end. Heads ball-



Drum ends, water wall piping, and headers in Seagram's Louisville distillery, showing K & M "Featherweight" 85% Magnesia insulation in use.

K&M INSULATION plays a part in making Seagram's

FINE WHISKIES SINCE 1857

In the distillery of Joseph E. Seagram & Sons, Inc., at Louisville, Ky., heat is efficiently conserved and controlled with the help of Keasbey & Mattison insulations. Among them is K & M "Featherweight" 85% Magnesia, one of the most efficient forms of heat insulation ever developed for temperatures up to 600°F.

The materials were supplied and installed by the Louisville Insulating & Roofing Co. who say: "To protect our reputation for good service as insulation experts we demand the highest quality in the insulation products we handle. That is why we use K & M. Once installed in a customer's plant, K & M insulations are their own best salesmen."

K & M engineers, working with K & M Distributors strategically located throughout the country, can point the way to real savings in your plant, too. Why not write Dept. 11 for further details ?

K&M

"FEATHERWEIGHT" 85% MAGNESIA

"The Time-Proven Insulation"

KEASBEY & MATTISON

COMPANY, AMBLER, PENNSYLVANIA

K & M insulation materials are the products of specialists. The Keasbey & Mattison Company has pioneered for over half a century in the development of superior Asbestos and Magnesia products. Its leadership as a producer of quality materials is equalled by its nation-wide system of prompt service through K & M Distributors.

SEE K & M's FIERY SNOWMAN AND EXHIBIT IN THE HOME BUILDING CENTER AT THE NEW YORK WORLD'S FAIR

HERE'S a catalog which enables you to select control equipment for pressure, temperature, level or flow with the assurance that it will be correct for the conditions of *your* application. For this new 40 page catalog, filed in Sweet's Catalog for your convenience, gives you the necessary data on types, sizes, capacities, uses and limitations—and presents a detailed picture of the Masoneilan line of modern, engineered controls.

Before buying any industrial control equipment consult the Masoneilan Catalog in Sweet's. Or if you do not have Sweet's Catalog write for Catalog No. 39 just off the press. Mason-Neilan Regulator Co., Boston, Mass.

The Masoneilan Line at your Fingertips—See Section 17/10 "Engineering" File; Section 10/10 "Power" File; or Section 9/10 "Process" File.

MASONEILAN
REG. U.S. PAT. OFF.

1186 ADAMS STREET
BOSTON, MASS., U.S.A.

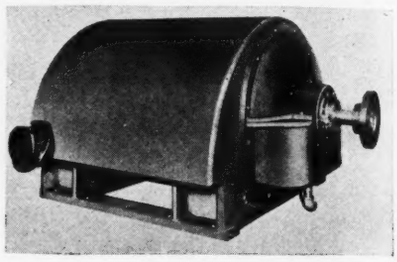
NEW YORK · BUFFALO · PHILADELPHIA · PITTSBURGH · TULSA
TOLEDO · CHICAGO · ST LOUIS · HOUSTON · LOS ANGELES
MASON REGULATOR CO. OF CANADA LTD. MONTREAL

bearing equipped and sealed against dust and dirt by combination labyrinth and composition seal. Troughing idler rolls supported in ribbed brackets of unbreakable malleable iron, which are in turn carried on an inverted angle base said to be self-cleaning.

Chain Belt Co, Milwaukee, Wis.

Induction Motors

HEAVY-DUTY, 3600-rpm, 600—3000-hp motors feature quieter operation with minimum windage noise and radio frequency-tested insulation. Bearings are combination oil-ring and forced lubrication. Wide-grooved rings provide lubrication in emergencies and during interruptions which



might occur to forced lubrication system. Motors may be started at full or reduced voltage and deliver normal starting torque with normal starting current.

Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.

Welding Blowpipe

TYPE W-26 blowpipe for heavy-duty welding, forging, pressing, bending, straightening, etc, is for welding and heating ranges above those of ordinary blowpipe. Extensions for extra-heavy work available, removing necessity of heat-shield. Large amount of heat delivered in short time said to cut working time.

Linde Air Products Co, 205 East 42nd St, New York, N.Y.

Heavy-Duty Engines

MODEL "CW" engines, designed for heavy-duty service, constructed with 1, 2, and 4 cylinders, rated from 2 to 22 hp. Have positive-drive gear oilers driven by crankshaft. Equipment includes electric starter, generator, water-circulating pump, fuel pump, lubricating-oil pump and filters, and combination carburetor for gaseous fuels and gasoline.

Novo Engine Co, Lansing, Mich.

Now G-E Insulated Cable with a NEW Heat-Resisting Varnished Cambric

Having HIGH DIELECTRIC STRENGTH LOW DIELECTRIC LOSSES

THOROUGHLY IMPREGNATED

Like our standard No. 995 black varnished cambric, No. 1799 cambric is made from a raw cloth, woven to G-E specifications, that contains the minimum of sizing. Such cloth acts like a sponge—soaks up the varnish and is thus thoroughly impregnated.

This accounts for the unusually high dielectric strength and low dielectric losses.

A check is readily made by tearing a piece of the cambric. If the cloth were not thoroughly impregnated, white threads would show up. They do not appear in the No. 1799 black varnished cambric shown here. It is black clear through. This cambric is more than just coated with a film of varnish insulation; it is thoroughly impregnated.

INSULATED CABLE
ALWAYS RIGHT

No. 1799 is a new G-E black varnished-cambric insulation.

It has the same high dielectric strength and the same low dielectric losses as our standard No. 995 black varnished cambric.

But—and this is the important feature—it has added heat resistance; cable insulated with No. 1799 cambric can be run at a conductor temperature of approximately 10 degrees (C) higher.

The use of No. 1799, therefore, should result in savings—savings in copper, in over-all diameter, in duct space, in first cost, and in other ways that mean dollars and cents.

We consider No. 1799 an important development—probably the outstanding development in varnished-cambric cable in all the thirty-eight years that General Electric has been making this type. We think, therefore, that you'd like to know more about it—and about the savings it makes possible.

If you have a job at hand for which you think this new cable would be suited, a G-E cable specialist will be glad to give you complete information and prices as well as any technical assistance you may desire. Address the nearest G-E sales office, or General Electric Company, Schenectady, N. Y.

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TYPE C

Devices that simply trap oil and water in compressed air lines *and retain it* will never keep your compressed air lines *absolutely free* from oil and water. During the collection process some of it is bound to get through in the form of moisture.

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The installation is quickly and easily made.

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TYPE A—used for all classes of industrial work where pressure variations are not necessary.

TYPE C—equipped with shut-off cock to permit of removing valve for cleaning without loss of air. A desirable feature where air is in constant use, particularly on the larger sizes.

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(Also manufacturers of the Dexter Valve Reseating Machines for reseating globe valves, gate valves and pump valve seats.)

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Engineers' Books

(Continued from page 116)

Particular attention is given to incandescent lamps and their uses; also, to high intensity mercury-vapor and sodium-vapor lamps. The sections dealing with interior and exterior illumination have been largely rewritten to make the data conform to modern practice. All references to illumination standards and nomenclature have been brought into accord with the latest recommendations of the Illuminating Engineering Society.

Those doing lighting work are frequently called upon to handle signal wiring jobs; for this reason, a section on signal wiring has been included. Material presented in this section conforms with practice recommended by the 1937 National Electrical Code.

Economics of Engineering

ECONOMICS OF BUSINESS ENTERPRISE (1939). By *Walter Rautenstrauch, Professor, Industrial Engineering, Columbia University. Published by John Wiley and Sons, Inc, 440 4th Avenue, New York, N. Y. 445 pages, 6x9 in., 100 charts and diagrams, 48 tables, board binding. Price $4.00.*

Power engineers interested in the economics of the industry they serve or in industry in general will find much to feed this interest in Prof Rautenstrauch's book, in which specific chapters touch directly on the economics involved in engineering decisions. By first showing the way a single business unit fits into the economic cycle, the author leads up to a general discussion of business costs and methods of estimating them and accounting for them. In chapters on interest, depreciation, economic worth of equipment and equipment replacement, the author gets over into territory already heavily-traveled and full of controversial features. The reader familiar with theory in this field will find much interesting material here, even though he may not be in entire agreement.

Succeeding chapters are unique in that, after explaining the break-even chart and its characteristics, the author applies it to studies of various industries and individual companies. Some of this material appeared in an A S M E paper. The book closes with chapters on analysis of financial statements and business enterprise on a national scale.

Throughout, extensive use is made of illustrative examples. This commendable feature is marred in at least one case by a series of typographical errors.

Furnaces

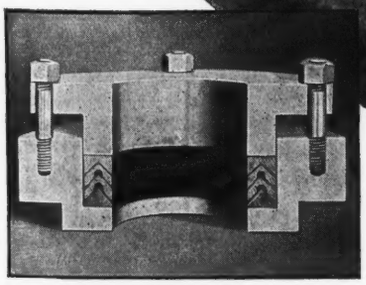
MODERN FURNACE TECHNOLOGY (1939). *By H Etherington. Published by J B Lippincott Co, Washington Square, Philadelphia, Pa. 524 pages, 64 illustrations, many tables and 2 folding plates, cloth binding. Price $12.00.*

In engineering, particularly, it pays

(Continued on page 146)

WINNER!

ONE ALWAYS STANDS OUT!



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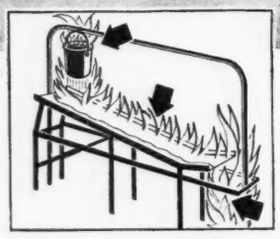

Diagram shows how this fire was set up. Gasoline flowing from leaking pail... flame cascading down a drainboard... spill fire blazing on ground. This trickiest of all blazes—a running-gasoline fire—was killed by a LUX Model 20 *in 7 seconds!*

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LUX extinguishers kill fires quickly... thoroughly... safely. Lux carbon dioxide gas is brutal to fire, *harmless* to everything but fire.

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If your fire hazards include flammable liquids or electrical equipment, Lux protection is your one best answer. Keep Lux portables near at hand. Or, if the hazard is intense, concentrated, let us tell you about the Lux Built-In System, automatically or manually controlled.

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Have you read the new brochure, "Don't Play With Fire"? Free, it tells about Lux Portable equipment.

***Safe-Harmless*—Lux carbon dioxide snow-and-gas is non-toxic, harmless to men, materials. Photo shows new Kidde-LUX Model Two, *one-handed,* trigger-control extinguisher.**

LUX SNUFFS OUT FIRE

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Please send your new booklet, "Don't Play With Fire"

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sometimes to stray across the vague lines which divide the field into specialties, and read books not primarily aimed at your specialty. The advantages of a fresh viewpoint will often compensate for lack of specific applicability. The above book, written for designers and operators of metallurgical furnaces, is a good case in point.

Boiler and furnace designers should find much of value and interest in the author's clear presentation of basic theory (combustion, heat transfer, and gas flow), in his comprehensive discussion of refractories, and in the extended chapter on physico-chemical considerations. Other features of the book are the simplified methods of calculation presented and the numerous tables and charts of data for use in furnace calculations.

Numbers

NUMBER—THE LANGUAGE OF SCIENCE (3rd Edition—1939). *By Tobias Dantzig, Professor of Mathematics, University of Maryland. Published by the Macmillan Co, 60 Fifth Ave, New York, N. Y. 320 pages, 12 illustrations, cloth binding. Price $3.00.*

This is a book on mathematics, written for the non-mathematical layman and the expert mathematician, which traces the history of mathematics through the ages, including primary number sense in animals, birds, and man. It traces the period when man first became conscious of the number, his development of the original into fractions, and combinations. It avoids most of the technical parts of the subject, but includes necessary symbols. Illustrations of the early uses of the number are given in a group of short stories and the end of book. Suggested reading on the subject is also given.

Diesels

DIESEL ENGINES—THEORY AND DESIGN (1939). By *Howard E Degler, University of Texas. Published by American Technical Society, Chicago. 270 pages, 5½x8½ in., 62 illustrations, 17 tables, board binding. Price $2.50.*

This is the fifth book in a series covering various phases of diesel-engine work. Others cover engine types, operation and maintenance, and diesel-electric plants; this volume concentrates on theory underlying diesel-engine operation, testing and performance of engines, and design of major parts. It is intended primarily for use of students, designers, and draftsmen and is written on the assumption that the reader has a working knowledge of mechanics. An interesting feature is a series of problems scattered through the text, relating to the same diesel engine, dimensions and data on which are given in some detail for the benefit of the student.

DIESEL HANDBOOK (6th Edition—1939). By *Julius Rosbloom. Published by Diesel Engineering Institute, 137 Franklin Street, Jersey City, N. J. 720 pages, 5x7 in., illustrated, flexible binding. Price $5.00.*

This new edition includes additional material on latest developments in diesel engines and auxiliaries. Newly introduced

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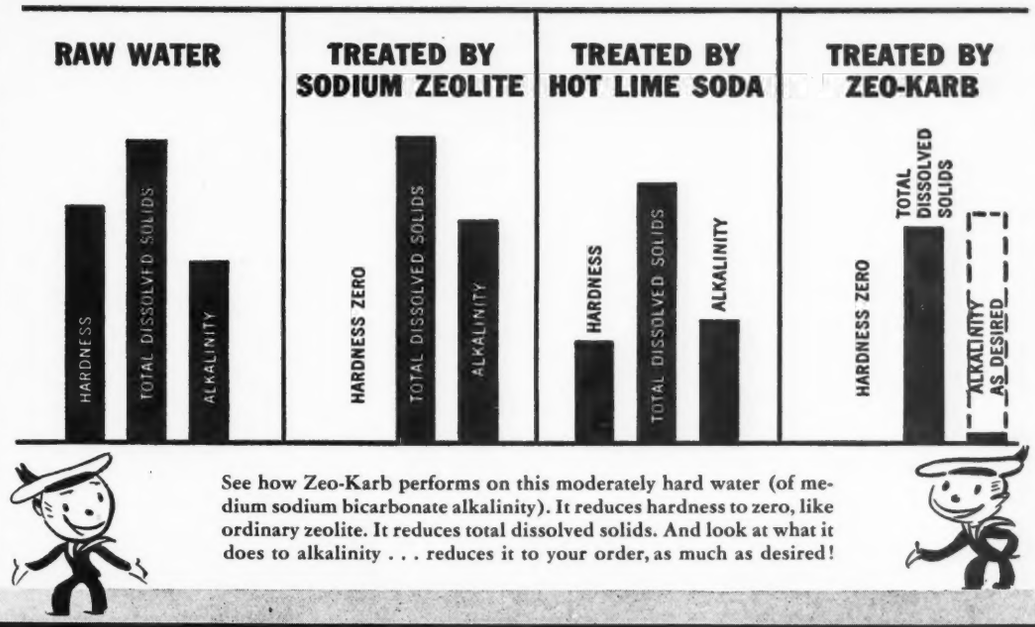
Amazing Results from New Feedwater Treatment



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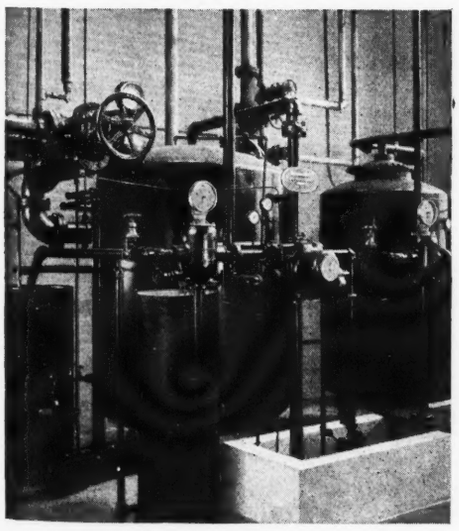

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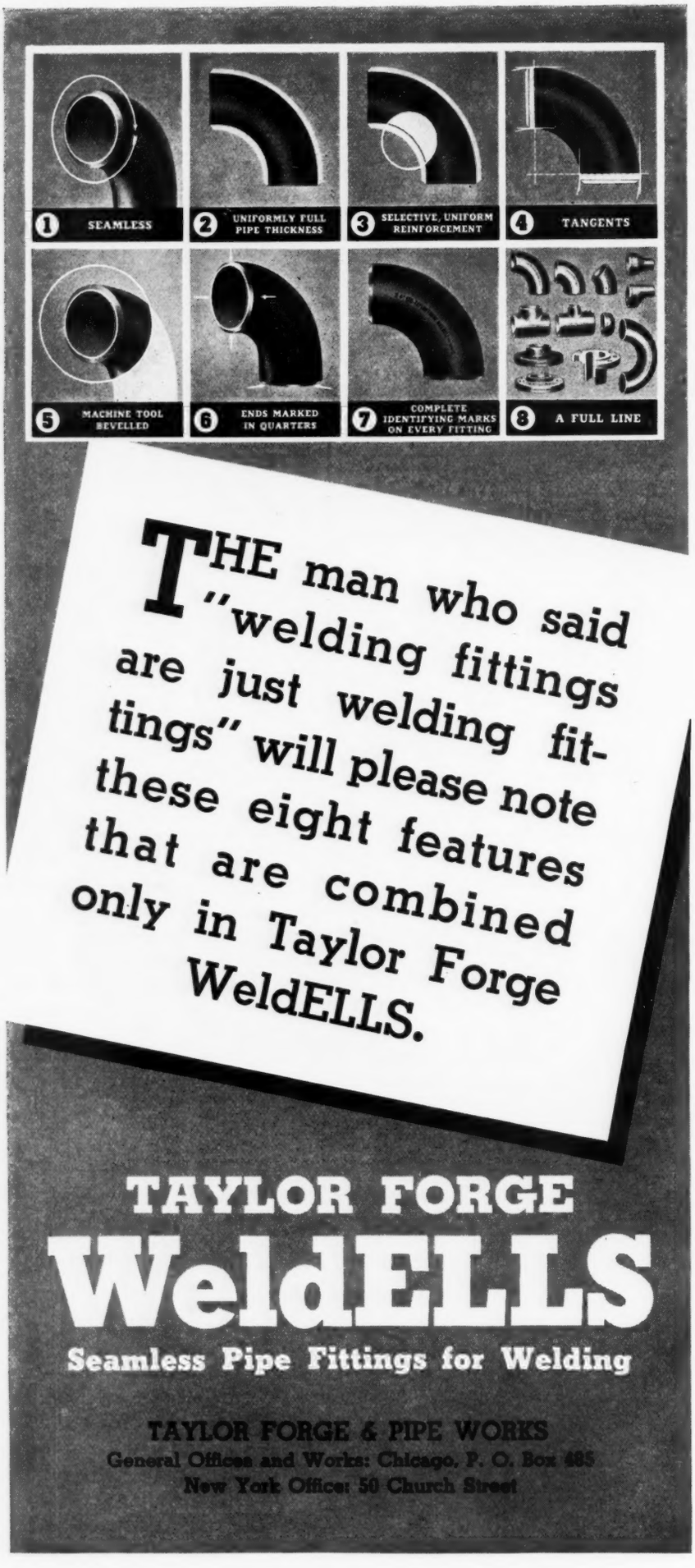
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accessories have been given space and a variety of new innovations are explained. A useful section contains latest questions and answers for license examinations, in accordance with rules of marine and land boards.

Air Conditioning

AIR-CONDITIONING ENGINEERS' ATLAS (1st Edition—1939). By *Clifford Strock, Associate Editor, and C H B Hotchkiss, Editor,* Heating and Ventilating. *Published by The Industrial Press, 148 Lafayette Street, N. Y. 76 pages, 9x12 in., 18 colored maps. Price $2.00.*

Heating and ventilating engineers owe Messrs Strock and Hotchkiss a debt of gratitude for bringing together, in a unique fashion, all the data on weather conditions that enter into design problems. This handy "atlas" puts at the finger tips much information now scattered through masses of relatively unorganized weather data.

Following a novel plan, the authors have divided their book into 18 sections, half dealing with winter conditions and half with summer. Heart of each section is a large colored map of the United States, zoned to show data on various phases of the weather of interest to the heating and ventilating engineer. Additional data in tabular form (for large cities) and explanatory notes complete each section. Sections cover such subjects as: number of days during a normal heating season, average temperatures during a normal heating season, lowest temperatures of record, outside design temperatures and wind data for winter heating, average maximum daily temperature for July, temperature and availability of well water, summer degree-hours, etc.

SUMMER WEATHER DATA (1939). By *J C Albright, vice-president, the Marley Co. Kansas City, Kansas. Published and compiled by the Marley Co. 180 pages, 54 pages of tabulations, 23 full-page maps. Price $3.00.*

Everything you want to know about the weather—that's what this book gives to the engineer and layman. Compiled under the direction of a vice-president in the company, it contains dew point maps, weather information covering 200 cities, sections on wet- and dry-bulb temperatures. A section on sunshine behavior is included with a part of the book covering wind characteristics.

BRIEF REVIEWS

THE ELECTRIC LIGHT AND POWER INDUSTRY IN THE UNITED STATES (1939). *Statistical Bulletin No. 6, 34 pages, 42 tables. Published by the Edison Electric Institute, 420 Lexington Ave, New York, N. Y. Price $.30 to members and employees, $.75 to non-members in U.S., and $.85 to foreign countries.*—Among the statistics shown in the latest bulletin are sources of energy, disposal of energy, availability of electric service, income statements of the various concerns, and salaries and wages of their employees. Other tables show number of

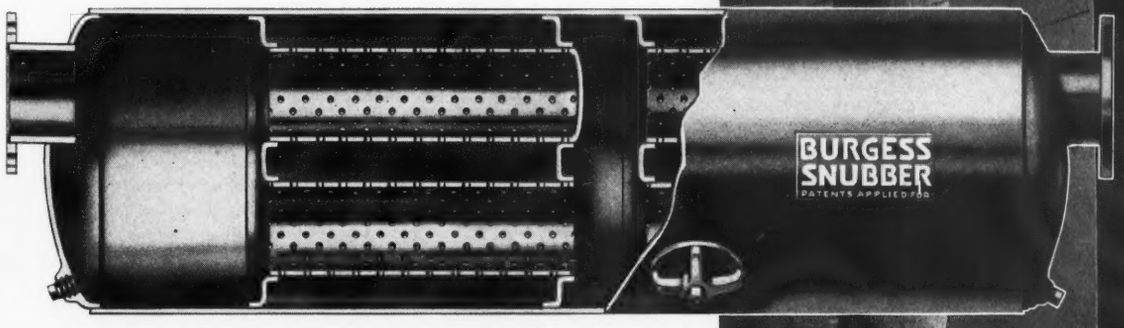
PREVENT DIESEL NOISE

without Increasing Fuel Consumption

Ordinary exhaust mufflers build up peak back pressures which reduce engine efficiency and increase fuel consumption considerably. The Burgess Snubber utilizes an entirely new principle for dissipating the high pressure slugs of exhaust gas that are the cause of exhaust noise. It snubs these slugs of gas before they reach the atmosphere and provides a non-restricted passage for the gases exhausted during the scavenging stroke. Hence, the exhaust gas is bled off in a smooth, quiet flow, with no back pressure peaks. Noise is prevented without increasing fuel consumption.

Burgess Snubbers Require No Tuning

As the Burgess Snubber has no resonators or acoustic devices, it does not require tuning. It can be mounted anywhere in the exhaust system, regardless of the length of piping. It is equally effective for quieting two-stroke and four-stroke cycle engines. Mail the coupon for further data.



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Send me booklet, "Snub the Slug and Stop the Noise."

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A Standard, set up in specifications, secures better built products. The Sterling Viking Engines are full load stationary engines. Witness the performance! Engines consist of more than rated horsepower and price.

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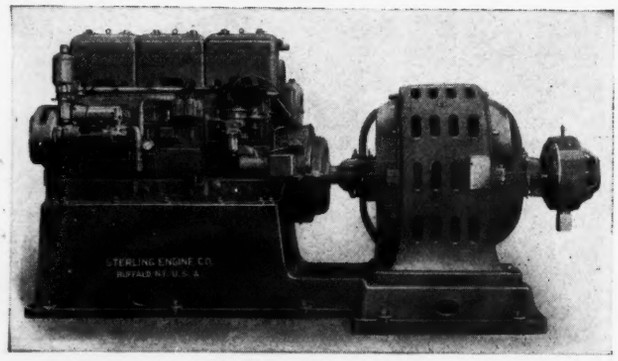

Guntersville Dam, T.V.A. emergency generator set, (Electric Machinery and Manufacturing Company Generator), driven by a Sterling Viking 6-cylinder engine rated 425 H.P., 1200 R.P.M. Engine officially government tested 12 hours, loaded 300 K.V.A. at unity power factor; produced far in excess its rated horsepower without employing the correction factor.

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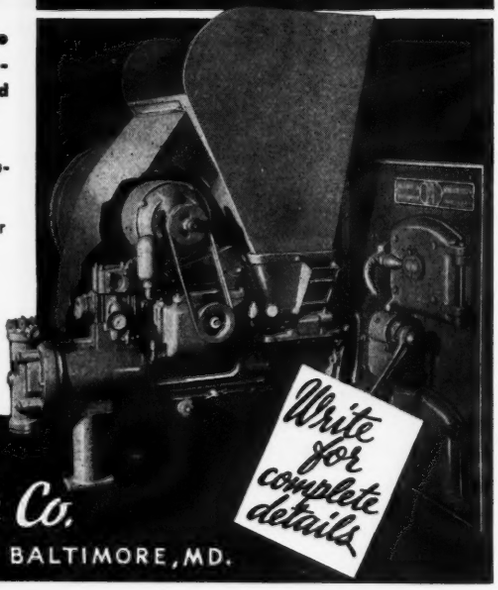

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customers, cost of living, cost of fuel, and other information concerning the industry in the United States.

LEFAX DATA. *By Lefax, Inc, Philadelphia, Pa.*—Recent Lefax data received includes the following: No. 12–253, "Basal Standards in Iron and Steel Analysis"; No. 9–281, "Vapor and Vacuum Heating Systems"; No. 8–174, "Methods for the Determination of Molybdenum in Ores and Steel"; No. 39–9, "Copper Welding"; No. 8–376, "Throttling Calorimeter for the Determination of Moisture in Steam"; and No. 4–187, "Hyperbolic Napierian Logarithms."

CORROSION IN THE REFRIGERATION INDUSTRY (1939). *Published by Mutual Chemical Co of America, 270 Madison Ave, New York, N. Y. 9 pages, no price listed.*—This booklet deals with the problem of corrosion in various refrigerating media, such as brine, and explains several treatments used to combat it.

SOME FUNDAMENTALS OF DRAFT HOOD DESIGN (1939). *By L C Price, Research Associate Professor, Mechanical Engineering, University of Arkansas. Published by Engineering Experiment Station, Fayetteville, Arkansas. 62 pages; numerous tables, graphs. Initial copy free, additional copies 25 cents.*—Data of tests presented in this booklet are for domestic type of heating plant, and fundamental design of draft hood for smaller furnaces is explained in detail, using charts to illustrate the text.

SILICA IN WATER (1939). By *M C Schwartz, Louisiana State University, Louisiana. 46 pages. Price 50 cents.*—Following a brief section on the calorimetric determination of silica, the bulletin is devoted to a complete bibliography with abstracts arranged chronologically, together with an author index.

NEW SCIENTIFIC AND TECHNICAL BOOKS (Summer-Fall, 1939). *Published by Chapman & Hall, Ltd, 11 Henrietta St, Strand, London W.C. 2. Available without cost.*—Contains list of books published or about to be published covering building and vibrational problems, electricity, photography, the disposal of sewage, etc.

BASIC FACTORS OF ADEQUATE WIRING (1939). *Published by the Edison Electric Institute, 420 Lexington Ave, New York, N. Y. 26 pages, tables, charts. Price 25 cents.*—The first of a series of three booklets which has as its aim the improvement in wiring, covers the vital need for adequate wiring, the residential market for wiring, the commercial market for the same, and what can be done to bring about needed improvements.

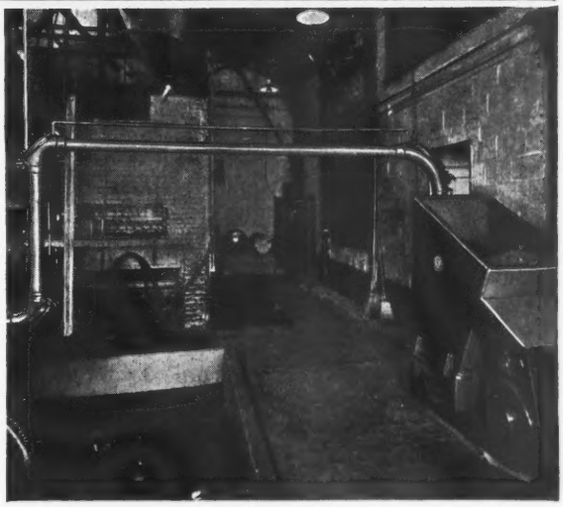
MECHANICAL ENGINEERING AS A CAREER (1939). *Published by the Institute for Research, 537 South Dearborn St, Chicago, Ill. 20 pages. Price $1.00.*—This monograph is ideal for the person contemplating mechanical engineering as a life work. It presents the education needed for such a career, a typical day in the life of both a mechanical operating and consulting engineer, and gives the attractive and the unattractive side of the profession.

CLEAN STACKS
THE OHIO CHEMICAL & MFG. CO.
—the sign that Iron Fireman users are saving millions
Are you getting your share of these savings?

Iron Fireman slashes fuel costs 26% for Ohio Chemical & Mfg. Co.

A clean stack—with only a fine gray haze emerging—is good business. It tells the world: "Here's a company that takes pride in its operations; is not inflicting a smoke nuisance on the community; *and is getting the most for its fuel dollar.*" And very often a clean stack (as in the picture above) announces the location of an Iron Fireman stoker . . . one of the thousands which are saving their owners millions of dollars a year in fuel costs.

In the Cleveland plant of the Ohio Chemical & Manufacturing Co., an Iron Fireman Pneumatic Spreader cut fuel costs 26 per cent. And this saving is only one of many benefits. Reports A. M. Russell, treasurer: "The ability of the Iron Fireman to instantly meet fluctuating load requirements has resulted in a more efficient operation in our processing . . . and its operation has conformed to the smoke abatement ordinance."



The Iron Fireman Pneumatic Spreader is a favorite with engineers in big and small plants. Has high flexibility of operation. Fires steam-size coal . . . fines burn in suspension, and larger pieces burn in a shallow layer on the grates. Adapted to efficient firing of a wide range of inexpensive coals. (*Shown above in Ohio Chemical plant.*)

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Automatic Coal Stokers

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It costs you less to spray metal with the new Speedmaster, which handles all metals that can be obtained in rod or wire form. Here is a low-priced spray gun that will save you money by eliminating replacement costs and shut-down periods—for companies everywhere are rebuilding and reconditioning Crank Shafts, Piston and Pump Rods, and a host of other types of circular machine elements. This easy-to-use gun is sturdily constructed to handle capacities as high, in the case of lead, as 80 pounds per hour. It will pay you to write today for further information.

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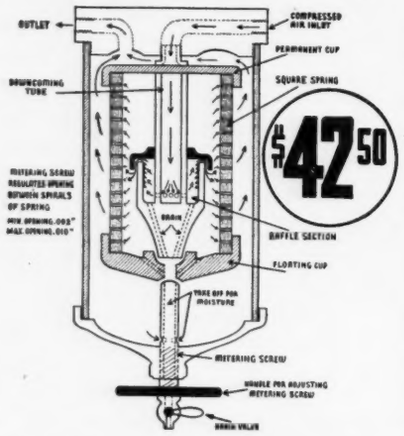

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Current Comment

Oil in Boiler Water

QUESTION 2, April, 1939, POWER, has recently come to my attention, in which a reader asks how to get rid of oil in boiler water. My experience prompts me to suggest the following solution:

For those troubled with oil, grease and dirt in boiler feedwater, there has been available for over 35 years several makes of oil and grease extractors which use terry cloth as a filtering medium. Dirty condensate passes through several layers of the filtering medium; the filter cloths are periodically removed, washed and renewed for service.

A spare set of filter stockings can be kept on hand; stockings last over a year with normal care and renewal cost is low. Results as low as two parts per million have been obtained, and boilers using these filters are usually in prime condition.

These filters are made in the single type, which include bypass valves for cleaning the filter; also in twin types, in which both bodies can be alternated for cleaning or both bodies used at the same time by adjusting the main 3-way valves. Pressure drop is observed on the gages supplied with the filter in order to determine the best time for changing the filter stockings.

Hoboken, N. J. A O MILLER

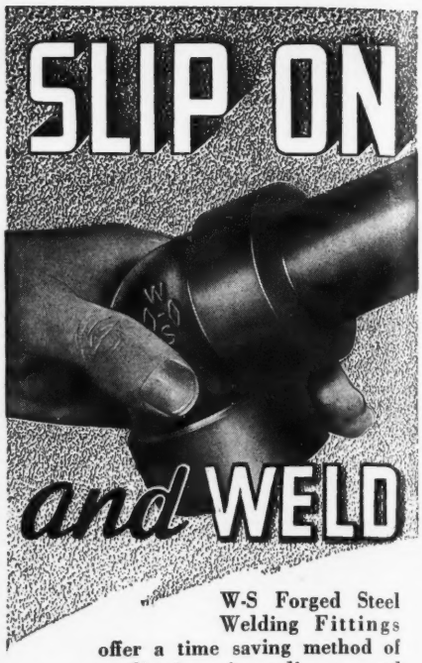
Experts Agree on Bleeder-Turbine Heat Rate

[EDITOR'S NOTE: *March* POWER, *page 72, presented a method of calculating bleeder-turbine heat rate, which, so far as we know, for the first time enabled anyone to translate typical bleeder-turbine guarantees into close and consistent heat-rate estimates without access to the manufacturer's detailed figures.*

In an extended correspondence, which space does not permit reproducing in full, Professor A M Greene, Jr, of Princeton University, attempted to rationalize the only method previously available with that of the authors of the paper, J Gottlieb and N D Gove of the Westinghouse Co. The methods are, of course, basically alike except that an assumed efficiency of expansion, required for the earlier method, is calculated directly from the maximum-bled line in the authors' article. Since this efficiency varies from zero to 69% over the bleed range, considerable judgment that used to be required is now replaced by accurately determined values.

The last letter of the correspondence sums up the situation and is printed here to illustrate a different viewpoint from that of the authors but arriving at the same result.]

Heat chargeable to generation of power is that needed for the condensed steam plus heat taken from the bled steam. The amount of heat chargeable to one pound of steam condensed is $(h_1 - ht_2)$, while that chargeable to one pound of bled steam is only that which has been turned into mechanical energy from one pound of

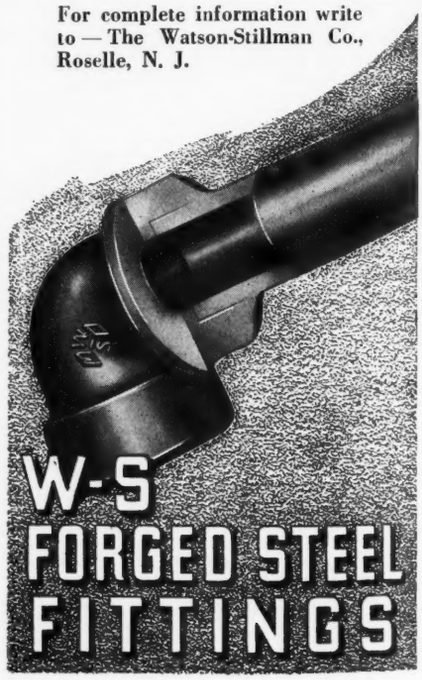


W-S Forged Steel Welding Fittings offer a time saving method of application, just slip on and weld. Beveling of pipe ends is not required; tack welding and the use of special fixtures for lining up and holding are eliminated.

With W-S Fittings the socket end supports the pipe and provides for positive alignment. The position of the weld facilitates the welding operation and also removes the danger of the formation of welding icicles. This, together with the fact that the bore of the fitting matches the bore of the pipe, assures unobstructed flow.

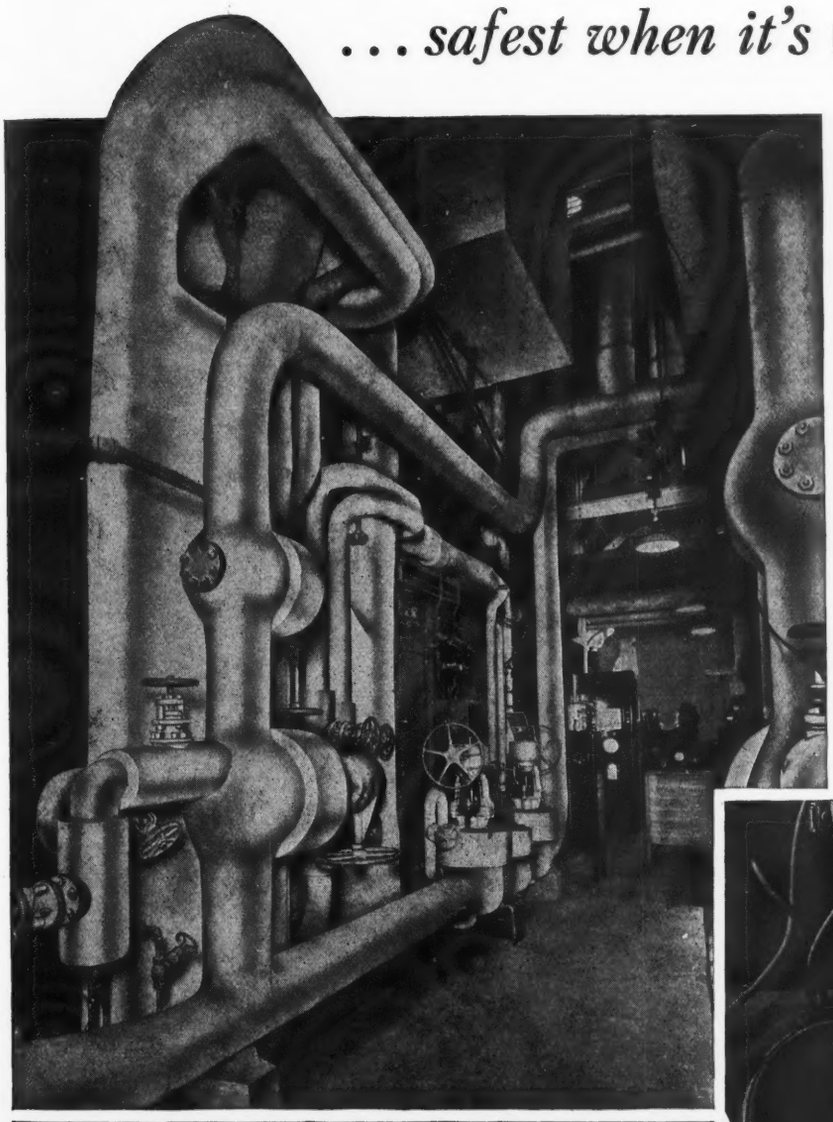
W-S Fittings are not only easier to install, they are more dependable in service. Bored from solid forgings of ample proportions, walls are of uniform thickness assuring a high factor of safety when used under extreme pressures and temperatures.

For complete information write to — The Watson-Stillman Co., Roselle, N. J.



Pipe under Pressure!

. . . *safest when it's* NATIONAL SEAMLESS



THE steam pipe that's *too safe* has never yet been made. For high-pressure steam lines are so vital to the successful operation of your plant—so much depends on their integrity—that the slightest unnecessary risk can never be justified.

That's why so many power plant operators today entrust their high-pressure steam to the power pipe that is the closest approach to the perfect tube—NATIONAL Seamless.

Here is power piping at its best. No weld along its walls to threaten safety. Nothing but solid, perfectly formed, highest-quality steel. Tough, strong walls, of uniform strength, that you can depend on for years of trouble-free service.

NATIONAL Seamless Pipe is the most widely used and most generally accepted pipe in the power industry. It is made to the A.S.T.M. specifications for plain carbon and alloy steel pipe. Write today for Bulletin No. 10.

THE BIRTHPLACE OF "WALLS WITHOUT WELDS"

This is the piercing mill, where billets of white-hot steel become NATIONAL Seamless Pipe. Only highest quality, flawless steel can endure the rolling and forging over the piercing mandrel. Any point of weakness is certain to reveal itself. You can depend on pipe that emerges from this piercing process.

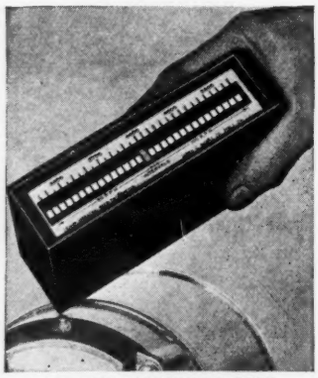
NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

INSTRUMENTS *for* MEASURING SPEED



"FRAHM" VIBRATING-REED HAND TACHOMETER

measures speed simply by touching some stationary part. Ranges from 900 up to 30,000 r.p.m.

"JAGABI" SPEED INDICATOR

A "vest-pocket" chronometric instrument for any speed up to 20,000 r.p.m.

NEW "JAGABI" UNIVERSAL HAND TACHOMETER

Centrifugal type. Pointer turns twice around dial. Three ranges up to 40,000 r.p.m.

We are "headquarters" for instruments for measuring speed. Bulletins 1505-P and 1575-P describe a comprehensive line of precision instruments, including those here illustrated. Write for copies. Consult us regarding your speed-measuring problems.

JAMES G. BIDDLE CO.

ELECTRICAL INSTRUMENTS

1211-13 ARCH STREET PHILADELPHIA, PA.

steam in the turbine. This latter is equal to the heat in the kwhr developed to the bleed point divided by the product of the mechanical efficiency, the electrical efficiency and the total steam flowing per hour. Gottlieb and Gove assume that the product of the two efficiencies is 0.9477 for simplicity, that is, 3412 ÷ 0.9477 = 3600. These give the following:

Total heat chargeable =

$$\text{Steam Condensed } (h_1 - h_{f2}) + \frac{3412}{0.9477} \times \left(\frac{\text{Kw to Bleed Point}}{\text{Steam to Throttle}}\right) \times \text{Steam Bled}$$

If this expression is divided by total kw, equation of Gottlieb and Gove results:

Heat rate per Kwhr =

$$(h_1 - h_{f2}) \times \left(\frac{\text{Steam Condensed}}{\text{Kw}}\right) + 3600 \times \left(\frac{\text{Kw to Bleed Point}}{\text{Kw}}\right) \times \left(\frac{\text{Steam Bled}}{\text{Steam to Throttle}}\right)$$

Mr Gove points out that the kw to bleed point is found by carrying a horizontal line from any point of the figure to the limiting line on the left, called the "maximum bleed line." Thus, for point *A* of Fig. 1 of the article, the kw to bleed point is 2140. If 30,000 lb are bled per hr with a total of 2500 kw, the kw to bleed point would be 1700.

As shown in the article, this reduces to 9970 Btu per kwhr for the point of 3000 kw with 40,000 lb of bleed per hour. Although this gives the heat rate for the whole machine, the full heat in the bled steam is credited to the unit, while of the steam entering the condenser only the enthalpy of the condensate can be credited to the unit.

Thus, using point *A*, 2140 kw are generated to bleed point and 860 kw are generated by the remaining part of the turbine. The enthalpy in one pound of steam at the bleed point is equal to the initial enthalpy minus that used in work, or

$$H_1 - \frac{3600 \times \text{Kw}}{\text{Total Steam}}$$

For initial steam at 265 lb and 125 F superheat, H_1 is 1279.5 Btu per lb, and the enthalpy at the bleed point is

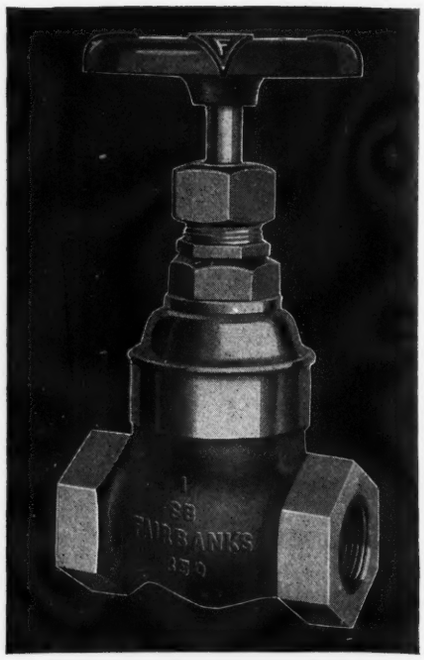
$$1279.5 - \frac{3600 \times 2140}{60,500} = 1151.7$$

This means that 1279.5 — 1151.7 or 127.8 Btu are removed per pound of steam and as the amount 1151.7 available for process work or for supply to the section below the bleed point is credited to the upper stage, heat rate for this section is

$$\frac{127.8 \times 60,500}{2140} = 3600 \text{ Btu per Kwhr}$$

This is really equal to an efficiency of 94.8%, the product of the mechanical efficiency and the electrical efficiency. The bleed is at 27 lb abs and the turbine exhausts at 2 in. abs. The entropy at 27 lb abs with an enthalpy of 1151.7 is 1.680, having been raised from the initial enthropy 1.615 by the internal friction and residual velocity.

Of the heat delivered to the condenser



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Valves Give Trouble-Free Service

Fairbanks Valves will give you more trouble-free years of service than you have ever thought possible.

Upon Fairbanks Valves has been focused all the knowledge and skill acquired during our experience of more than half a century. They embody every known feature that would tend to make them more perfect.

Nothing is spared in the cost of materials and labor to make every Fairbanks Valve the best possible.

They're easy to manipulate, easy to repack, easy to renew, and they seat perfectly. They assure long life and low maintenance cost.

Sold by distributors everywhere. Write for Catalog No. 21.

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Valves, Dart Unions, Hand Trucks and Wheelbarrows

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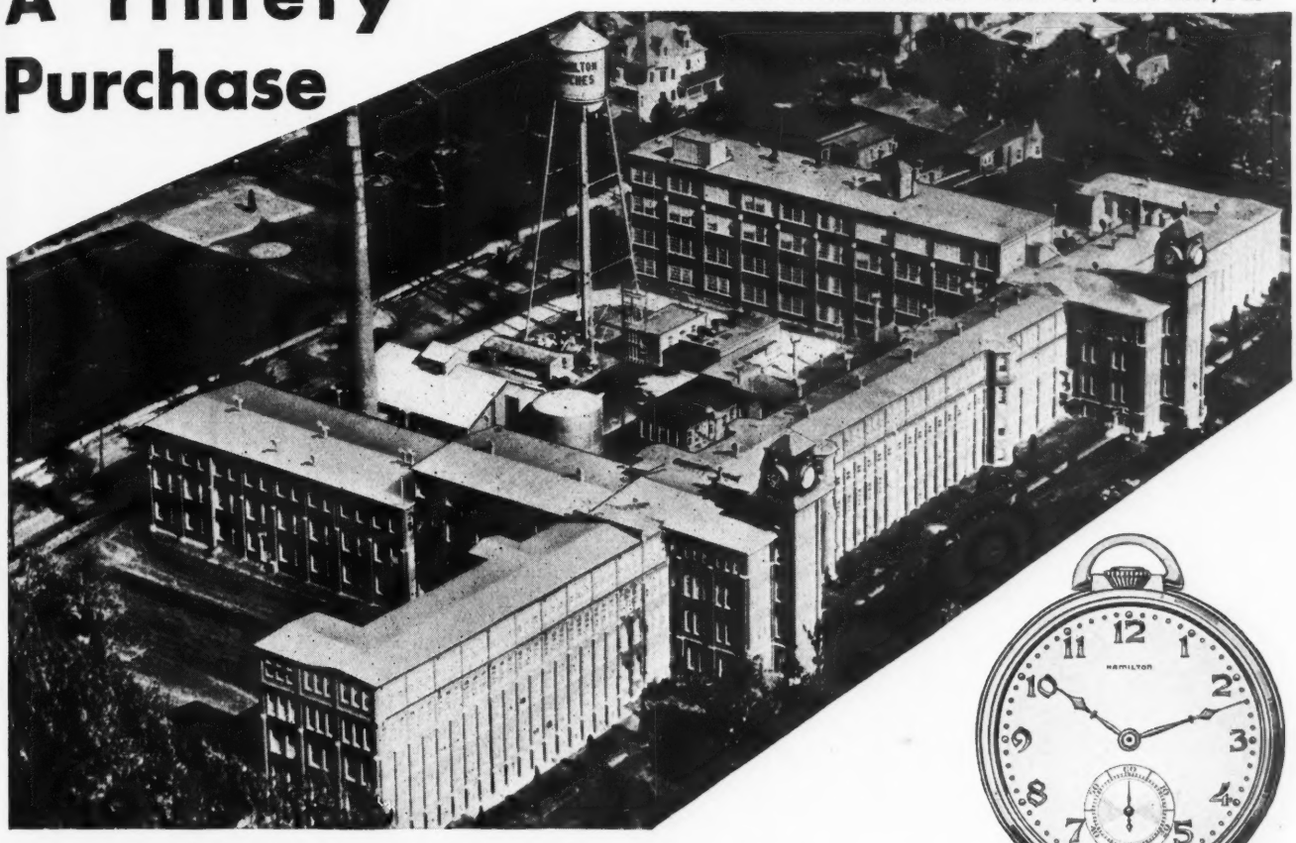
Factories: Binghamton, N. Y. Rome, Ga.

A Timely Purchase

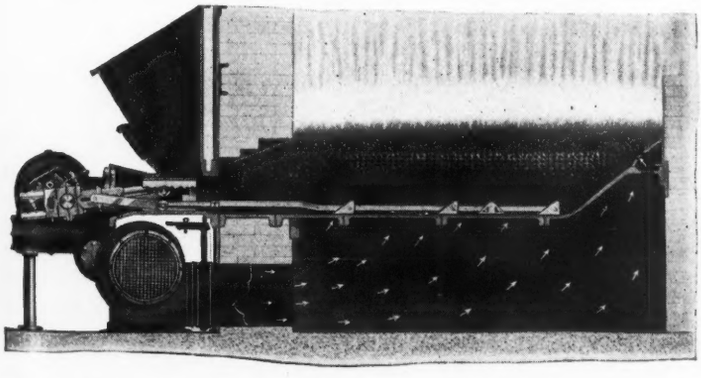
Home of the Hamilton Watch Co., Lancaster, Pa.



Hamilton Watch Company Buys Another

Detroit Stoker

Hamilton Watches have been used by generations because of their fine quality and precision time keeping. An organization making such a product naturally has a high appreciation of good design—sound workmanship and outstanding performance, which extends to all parts of the Hamilton Organization. It is a matter of pride to us that Hamilton Watch Company, Lancaster, Pennsylvania, have placed a repeat order for Detroit Stokers. Detroit Stokers are preferred by those who appreciate outstanding quality and performance. ***Write for Bulletin 630***



DETROIT STOKER COMPANY

Sales & Engineering Offices
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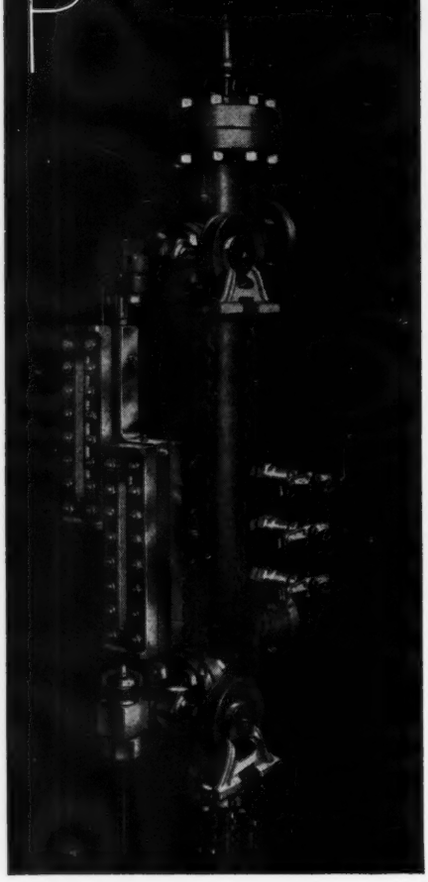
POSITIVE
Protection



Yarway's unique Hi-Lo Alarm mechanism utilizes balanced *solid weights* that are as indestructible and unchanging as the metal itself. Operating on the displacement principle, they literally "weigh the water level."

When the high or low water emergency occurs—instant, positive, powerful, hair-trigger *action* results—giving warning of danger by whistle, light, or both.

Yarway Water Columns, eight standard models, iron bodies with screwed connections for pressures up to 250 lbs., forged steel bodies with flanged connections for pressures up to 1500 lbs., are fully described in Catalog WG-1806. Write for a copy and working model.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

YARWAY
FLOATLESS HI-LO ALARM
WATER COLUMN

only the enthalpy of the liquid at 2 in. abs or 69.1 Btu per lb can be credited to the turbine. The heat rate for this section is

$$\frac{20{,}500\ (1151.7-69.1)}{860} = 25{,}820 \text{ Btu per Kwhr}$$

The combined heat rate is

$$\frac{3600\times 2140 + 25820\times 860}{3000} = 9970 \text{ Btu per Kwhr}$$

as shown by the formula of Gottlieb and Gove.

The important gain in the heat rate of the bleeder turbine is due to the fact that the first section to the bleed point is credited with all of the heat in the exhaust from that section.

Princeton University A M GREENE, JR

How to Select Industrial Thermometers

I was very much interested in the article "How to Select and Install Industrial Thermometers," MAY POWER, especially the statement on page 89, which reads: "Finally, do not purchase a mercury-in-glass thermometer if a dial thermometer would be better suited for the service."

We consider the mercury-in-glass industrial-type thermometer the standard by which other instruments are checked, including dial thermometers, and in certain industries such as the dairy and canning, regulations require the use of mercury-in-glass thermometers where indicating instruments are used. Only mercury-in-glass thermometers are approved.

In many other industries such as in power plants, if accuracy is a prime requisite, the mercury-in-glass thermometer is always used. The dial thermometer is used where it is necessary to locate the dial at a point distant from the bulb or where excessive vibration exists and it is necessary to remove the indicating device from the point of application of the bulb to get away from vibration.

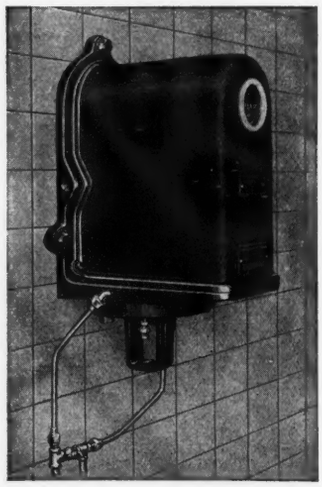
Unless these points are brought out it might give the reader the impression from reading this article that mercury-in-glass thermometers should never be used if they can use a dial thermometer. The two instruments are supplementary, and each one has its own particular sphere of usefulness, so that one instrument cannot be said to replace the other. Aside from this one criticism, I think the article is good and brings out most of the salient points on industrial-thermometer design.

Rochester, N. Y. J W SCHWARZ
Taylor Instrument Companies

Power Lines

(Continued from page 122)

Authority, was sworn in as a member of the Federal Power Commission for the term ending June 22, 1944. Mr. Olds fills the position vacated by Frank R McNinch, who was transferred to the Federal Communications Commission. He was born in



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puts a toy to . . . . work

For years the Gyroscope, with its complex and peculiar force actions, has presented an intriguing study to the engineer and scientist . . . Once used only as a toy or for personal transportation via the bicycle, in late years its principle has been adapted to new and useful services . . . Simplex is proud to offer for the first time in the industrial field an instrument employing gyroscopic action—The

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GYROMETER

an accurate and sensitive meter for totalizing the flow of any fluid . . . Built for a wide range of capacities and very reasonably priced.

Write today for technical data

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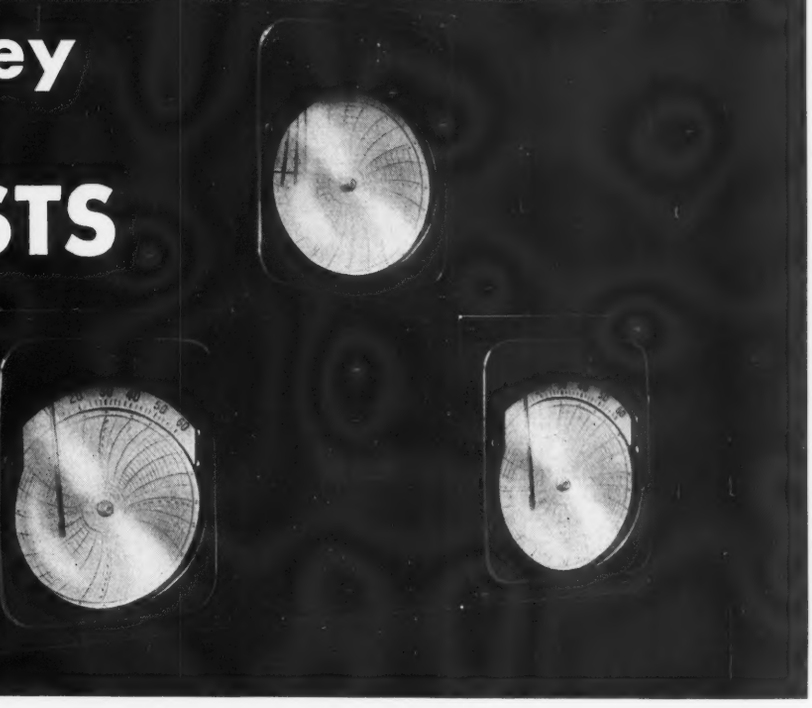
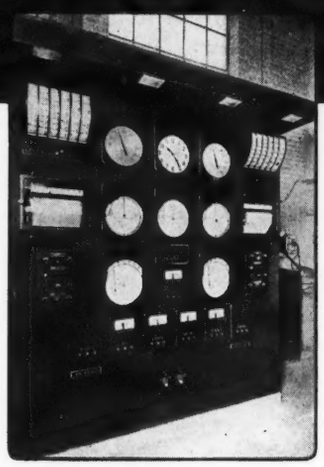
VALVE & METER CO.
6780 Upland St.
PHILADELPHIA, PA.

How COCHRANE METERS Save Money on FUEL COSTS for Sloane-Blabon



Cochrane Electric Flow Meters on bottom row measure steam output from two 50,000 lb./hr. boilers. Cochrane Temperature and Pressure Recorder shown above measures pressure of steam, and pressure and temperature of feed water.



Instrument panel at plant of Sloane-Blabon Corp., 2nd St. & Erie Ave., Philadelphia, Pa.

Write for Bulletin 2096 on Electrical Flow Meters and Bulletin 2094 on Mechanical Flow Meters

COCHRANE Flow Meters long ago earned for themselves the title of "Cash Register of the Coal Pile"—and at the plant of the Sloane-Blabon Corp. of Philadelphia, they have fully justified that title.

In conjunction with a Cochrane Pressure and Temperature Recorder and other instruments, the Cochrane Flow Meters are used as one means of checking the efficiencies of various types of coal. During 1938, coal from fifteen different mines was used and the relative fuel costs per 1000 lb. of steam carefully calculated with the information obtained from the Flow Meter records. The fuel selected on the basis of these records has resulted in an average annual steam cost of only 16.73 cents per 1000 lb., including handling to the stoker hopper.

During 1938, 257,822,733 lb. of steam were generated at an efficiency of 82.6%.

Cochrane Flow Meters and other instruments, because of their high sensitivity, their extreme accuracy, and the ruggedness which is built into them, are being relied upon by more and more industrials and utilities for records upon which savings can be effected.

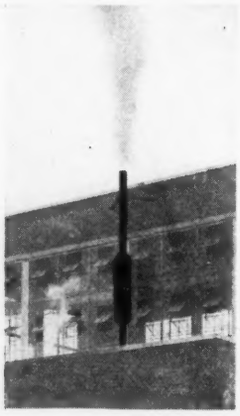
COCHRANE CORPORATION, 3106 N. 17th St., PHILADELPHIA, PA.

COCHRANE

WATER SOFTENERS • DEAERATING HEATERS • FILTERS • BLOW-DOWN EQUIPMENT • VALVES • FLOW METERS

NO STEAM ROAR WITH MAXIM SILENCERS

Here's a problem totally different from engine or compressor silencing, but still merely routine to Maxim. Model BR9 illustrated, a standard product, is indicative of the variety of MAXIM SILENCERS.

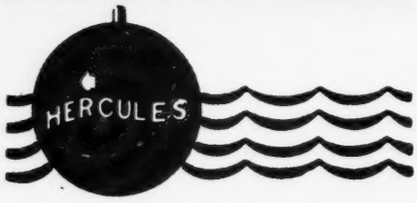


15,800 lbs. Steam Per Hour Passing Thru BR9

Take advantage of the engineering experience offered by The Maxim Silencer Company, and be assured of permanent freedom from bothersome noise.

THE MAXIM SILENCER CO.
Hartford, Conn. New York, N. Y.

HERCULES
Seamless Copper
FLOATS



GUARANTEED TO STAND UP!

Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

Fabricated of seamless copper under our special spinning process, Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

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ease in pump assembly

Quick precision adjustment of reciprocating pump bearings and gear shaft, for example . . . By simply peeling the paper-thin laminations from the solid brass Laminum shim. Right at the job . . . in assembly AND service adjustment! No filing, no machining. Write for Laminum sample (.002 or .003 in. laminations).

LAMINATED SHIM CO., INC. 21-60 44th Ave., Long Island City, N. Y.
933 Cleveland Detroit Milwaukee

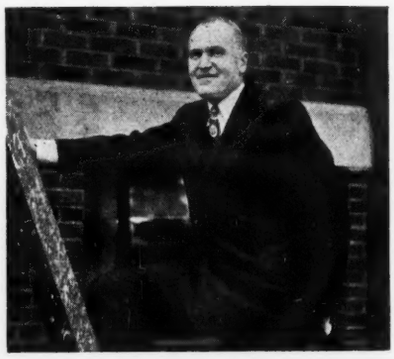
LAMINUM
Precision adjustment **SHIMS**

Rochester, N. Y., and was graduated from Amherst College in 1912.

L M Bang has been appointed district manager of the central-western Stoker Div of the Link-Belt Co, Chicago. Mr Bang was formerly with the Whiting Corp, and has been identified with the stoker industry for a number of years.

Richard C Poucher has been added to the sales staff of Research Products Corp, Madison, Wis. He was formerly with the Diamond Iron Works, Inc. Mr Poucher is a graduate of the University of Minnesota, Mechanical Engrg Dept. He will take charge of the sales engineering problems for the Air Filter Div, Research Products Corp, in Ohio, Michigan, Pennsylvania, and New York.

George A Miller has been promoted to the vice-presidency of the Key Co, East St. Louis, Ill., succeeding Dr Frederick E Key,



George A. Miller

one of the cofounders of the company, who died recently. Mr Miller has been with the Key Co since 1924.

Alvin H Baer, after an absence of 7 years, has rejoined the Frick Co, Waynesboro, Pa., as executive assistant, with headquarters at the New York office, 370 Lexington Ave. He had previously spent more than 30 years with the company and has numerous patents dealing with refrigeration and ice-making to his credit. In 1931 he was elected president of the American Society of Refrigerating Engineers, and it was during his term that the Refrigerating Data Book was published. Mr Baer has also served as president of the Refrigerating Machinery Assn.

Two Loeffler Boilers for Bucharest Station

Bucharest power station (Rumania) recently placed an order with the Vitcovice Mines, Steel and Iron Works, Czechoslovakia, for two Loeffler boilers, 1900 lb pressure and 935 F. The two turbines will be Brown Boveri, 16,200 kw each.

Feedwater preheating will be done by exhaust steam of the auxiliary machinery, and in the last stages, feed will be preheated to 375 F. At this temperature, feedwater will be pumped into the economizer at high pressure.

"Our Diesels stay CLEAN AND IN FINE CONDITION with GULF DIESEL OIL in Service"

...SAYS THIS PLANT ENGINEER

. . . "No Stuck Rings or other Common Engine Troubles"

"THESE engines are in the finest condition we've ever seen them," says this plant engineer. "And last year we saved over $4,000.00 on maintenance costs with Gulf Diesel Lubricating Oil in service. The efficiency of our Diesels has been greatly increased."

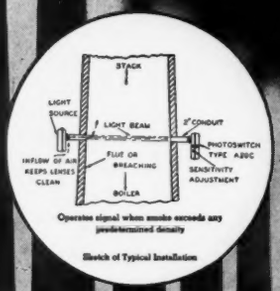
When you use Gulf's higher quality Diesel lubricating oil, you are using a lubricant which has been approved by 50 of America's leading Diesel engine builders for the lubrication of units they manufacture. This outstanding recognition has resulted from many years of research and practical tests in the field of Diesel engine lubrication by Gulf technologists.

You can depend on the Gulf engineer's recommendations for the proper lubrication of *your* Diesels. He has had broad experience with equipment similar to yours and can give you worthwhile suggestions which will help you increase efficiency and keep maintenance costs at a minimum.

Gulf's higher quality oils are quickly available to you through more than 1100 Gulf warehouses located in principal distributing points from Maine to Texas. Give them a trial in your equipment.

GULF OIL CORPORATION — GULF INDUSTRIAL LUBRICATION — GULF REFINING COMPANY

PHOTOSWITCH
Electric Eye
INCREASES FUEL ECONOMY—AVOIDS SMOKE NUISANCE



Operates signal when smoke exceeds any predetermined density

Sketch of Typical Installation

DEPENDABLE—RUGGED
• GUARANTEED •

SOLVES YOUR OTHER CONTROL PROBLEMS

Wherever objects are counted, electrical machinery automatically controlled, or warning signals are used, PHOTOSWITCH will do the job better and more economically.

Write for Catalogue.

LOW IN COST

PHOTOSWITCH INCORPORATED
CAMBRIDGE • MASSACHUSETTS

District offices in all principal cities

When nuts work loose ..anything can happen, *and often does!*

Protect your equipment with

UNSHAKO

The Nuts that can't shake loose

Fig. 1513 Pat'd & Pat's. Pending

It's always hazardous for nuts to work loose. The effect may mean injury to some workman or damage to your equipment. Play safe. Use "Unshako" Self-Locking Nuts exclusively on foundations and all moving parts of Diesels, Reciprocating Engines, Pumps, Conveyors, Generators, Stokers, etc. They "spring to life" and grasp the bolt or stud whenever there's a backing-off tendency and thereby insure permanent tightness. Of course, they can be removed with a wrench and reused if desired. Write for complete details.

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA.

Boston, Detroit, Indianapolis — Box 577 — Chicago, St. Louis, San Francisco

STRAWS

Pointing the way business winds blow

ALABAMA——Watson Cold Storage Co, Gastonburg, J C Watson, head, plans 1-story cold storage plant on Highway No. 43, near Demopolis, where site has been acquired. A locker system of about 100 units will be installed. Cost close to $40,000, with equipment.

Decatur Box & Basket Co, Decatur, plans rebuilding of boiler house and plant, recently destroyed by fire. Loss about $50,000, with equipment.

Farm Security Administration, Mobile, contracted C G Mitchen, Lawndale, N. C., at $35,910 for cold-storage and meat-processing plant at Crossville, Tenn., exclusive of equipment, for which awards will be made separately.

Southern Natural Gas Co, Birmingham, plans welded-steel pipe-line from connection with main system near Rome, Ga., to Chattanooga, Tenn., about 60 miles, for natural-gas transmission. Right-of-way is being secured. Company has contracted to furnish gas at last noted place beginning Jan 1, 1940. Cost over $250,000 with regulator stations and other operating structures.

ARKANSAS——Augusta plans improvements in municipal power plant, with new 6-cylinder diesel, 500-kw generator and equipment. Estimates of cost being made.

CALIFORNIA——Imperial Irrigation Dist, El Centro, M J Dowd, chief engineer and general superintendent, contracted Charles W Pettifer Co, 703 West Fourteenth St, Long Beach, at $308,466.20 for construction of hydro-electric power plant at Drop No. 3, All-American Canal, near Calexico, Bids for equipment are being awarded separately.

Livestock Feed Co, 639 South Spring St, Los Angeles, plans power house at new processing and packing plant at 2400 Harriett St, with high-pressure boilers and equipment. Entire project will cost about $100,000. R McC Beanfield, Chamber of Commerce Bldg, Los Angeles, architect.

Taft School District, Taft, plans central-heating plant at Roosevelt school. Estimates of cost are being made. Bids are scheduled to be asked soon.

Walt Disney Productions, 2400 South Alameda St, Burbank, plans power house at local motion picture studio, including refrigerating plant. Cost about $35,000.

Pasadena contracted Marley Co, Kansas City, Mo., at $29,357 for induced-draft, double-sheathed cooling tower at municipal power plant.

COLORADO——H C Curnow & Associates, Inc, Grand Junction, plans cold-storage and refrigerating plant on Ninth Ave, 60x70 ft. Cost about $40,000, with equipment.

American Crystal Sugar Co, Boston Bldg, Denver, plans power house at branch beet-sugar mill at Missoula, Mont. Work will be done in conjunction with mill improvements. Cost about $100,000.

Bureau of Reclamation, Denver, has low bid from General Electric Co, Schenectady, N. Y., at $52,500, for furnishing and delivering two 2500-kva, 2400-volt, vertical-shaft, ac generators, each complete with direct-connected main exciter, and pilot exciter, excitation-control and voltage-regulator equipment, for installation in Shasta power plant, Kennett Division, Central Valley project, Calif. Award will be made soon.

Denver Housing Authority, Denver, James Q Newton, chairman, plans central-heating plant for housing project in Lincoln Park district, comprising 4 blocks in area. Cost about $1,450,000. T H Buell & Co, 730 Fourteenth St, Denver, architects. Also central-heating plant for similar project on site between Downing and East 26th Sts. Cost about $950,000. Burnham L Hoyt, Colorado National Bank Bldg, Denver, architect. Financing for both developments is being arranged through Fedeal aid.

CONNECTICUT——Hartford Rayon Corp, Rocky Hill, has plans for new steam-electric power plant at local mill. Cost about $125,000. Financing has been arranged.

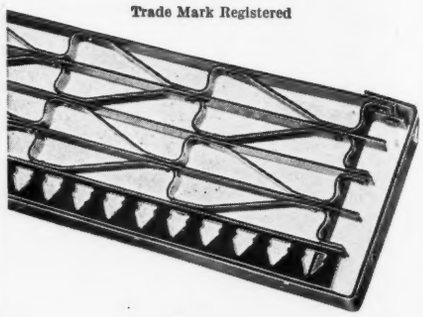
Blake & Johnson Co, Thomaston Ave, Waterville, will build 1-story addition, 122x200 ft., to screw machine products plant. Cost close to $100,000 with machinery and equipment.

FLORIDA——Growers' Cold Storage Co, NW 22nd St, Miami, plans improvements in cold-storage and refrigerating plant, with equipment for large increased capacity. Cost reported over $200,000, with machinery.

Construction Service, Veterans' Admin-

ARROWHEAD GRATINGS & TREADS

Trade Mark Registered



Arrowhead Treads are strong and slip-proof. They are supplied with the defined nosing as shown, or plain. For interior or exposed stairs, the self cleaning, foot-gripping properties of Arrowhead treads are of valuable assistance in the promotion of safety and prevention of accidents.

Engineers Handbook Sent on Request

ARROWHEAD IRON WORKS

431 W. 5th St. KANSAS CITY, MO.

OLD operating men know Dixon's Graphite by long experience. The youngsters have learned it too. So have their bosses.

That's why Dixon's Ticonderoga Flake Lubricating Graphite, popular for more than half a century, is still a favorite the world over. Through all the development in equipment, with pressures and temperatures higher than ever, this fine old Dixon product has more than held its own.

As a co-lubricant with oil or grease—for coating packings or gaskets—and on all joints—Dixon's Ticonderoga Flake Lubricating Graphite is unequalled—because it stands up to its work where other lubricants squeeze out, burn out, or wash out.

Particle Size No. 1—large, unctuous flakes.

Particle Size No. 2—finely subdivided, powdered flakes.

Write for Booklet C-44

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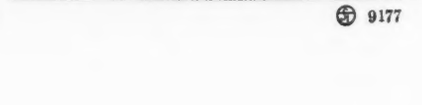

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istration, Washington, D. C., contracted Continental Contracting Co, Fort Dodge, Iowa, at $17,500 for boiler unit and accessories for power house at Bay Pines.

ILLINOIS——International Harvester Co, Motor Truck Division, 180 North Michigan Ave, Chicago, has approved plans for 2-story factory branch, shop, storage and distributing plant, 232x267 ft, at Chappel St and Gilbert Ave, Cincinnati, Ohio. Cost over $175,000, with power equipment, etc. Otto A Kruger, first noted address, chief engineer.

Shell Oil Co, Shell Bldg, St. Louis, Mo., has approved plans for additions and improvements in main oil refinery at Wood River, including new production units to increase crude oil-handling capacity from 50,000 to 75,000-bbl per day. Work will include expansion in power house, pumping station and other mechanical divisions. Cost about $8,000,000.

John Deere Plow Works, Inc, 1225 Third Ave, Moline, has approved plans for 5-story and basement addition, 95x150 ft., for improvements in machine shops, tool rooms, service and other departments. Cost over $150,000, with power equipment and other machinery.

State Division of Architecture and Engrg, Springfield, has following low bids for equipment for power house addition at state hospital, Dixon, and will make awards soon: Boiler and accessories, Wickes Boiler Co, Saginaw, Mich., $23,682; stoker, Robert Gordon Co, Chicago, $13,249; coal and ash-handling equipment, Conveyor Systems, Inc, Chicago, $3200; and piping, S J Reynolds Co, Chicago, $14,955.

Central Commercial Co, 332 South Michigan Ave, Chicago, has approved plans for processing plant for production of roofing granules and other pulverized colored-stone specialties at Pembine, Marinette County, Wis. A power house will be built. Cost close to $275,000.

INDIANA——Hecker Products Corp, 1437 West Morris St, Indianapolis, manufacturer of shoe polishes, etc, plans 3-story addition, 100x128 ft. Cost about $100,000, with power equipment and other machinery. Lockwood, Greene Engineers, Inc, 30 Rockefeller Plaza, New York, N. Y., architect and engineer.

General Gas Pipe Line Corp, Circle Tower Bldg, Indianapolis, plans 20-in. welded-steel pipeline from gas-field area in Hart County, Ky., to Hamilton County, where connection will be made with present system, for natural-gas transmission. Line will total about 180 miles, including 40 miles of 3-, 4-, 6- and 8-in. steel pipelines for gathering system in gas-field district. Company has made application for permission and will have hearing before Federal Power Commission, Washington, D. C., Sept 7.

Rush County Frigid Lockers, Inc, Rushville, B L Trabue, president, has approved plans for immediate erection of 1-story cold-storage plant, with 500 locker units. Cost about $40,000, with equipment.

IOWA——Woodbine contracted Fairbanks, Morse & Co, Chicago, Ill., for municipal power plant at $108,406, including 3 diesel-gengrators and equipment, with electrical distributing system. Bond issue of $115,000 is available.

New London will award contracts soon for one 400-kw turbine-generator and accessories; boiler unit with rated capacity of 14,000 lb ps, including stoker and accessories; surface condenser, cooling tower and equipment for improvements in municipal power plant. Young & Stanley, Inc, Muscatine, consulting engineers.

La Porte City contracted Worthington Pump & Machinery Corp, at $128,129 for 500-hp diesel-generator and equipment for improvements in municipal power plant. Young & Stanley, Inc, Muscatine, consulting engineer.

New Hampton is considering pipeline system for municipal steam distribution in business district and for public buildings in other areas. Cost about $50,000. Service will be furnished from municipal power plant, where work is being carried out to cost about $183,000. Ralph D. Thomas & Associates, Inc, 1200 Second Ave, South, Minneapolis, Minn., consulting engineer for power station project.

Bd of Black Hawk County Supervisors, Court House, Waterloo plans improvements in boiler plant at county home, with new boiler unit and equipment. Ralston & Ralston, Waterloo Bldg, Waterloo, architects.

KANSAS——State Bd of Regents, State House, Topeka, has low bid from Westinghouse Electric & Mfg Co, at $28,266 for 1000-kw turbine-generator and accessories for power plant at State College of Agriculture, Manhattan, and will make award soon.